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1909-1910

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REPORT ON CONDITION

OF

WOMAN AND CHILD WAGE-EARNERS IN THE UNITED STATES

IN 19 VOLUMES

VOLUME XI: EMPLOYMENT OF WOMEN IN THE METAL TRADES

Prepared under the direction of

CHAS. P. NEILL

Commissioner of Labor

by

LUCIAN W. CHANEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

In the Senate of the United States,
June 15, 1910.

Resolved, That the complete report on the condition of woman and child wage-earners in the United States, transmitted and to be transmitted by the Secretary of Commerce and Labor in response to the act approved January twenty-ninth, nineteen hundred and seven, entitled "An act to authorize the Secretary of Commerce and Labor to report upon the industrial, social, moral, educational, and physical condition of woman and child workers in the United States," be printed as a public document.

Charles G. Bennett, *Secretary.*

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LETTERS OF TRANSMITTAL.

Department of Commerce and Labor,
Office of the Secretary,
Washington, January 4, 1911.

Sir: In partial compliance with the Senate resolution of May 25, 1910, I beg to transmit a report showing the results of a study of the employment of women in the metal trades.

This report has just been completed and is the eleventh section available for transmittal of the larger report on the investigation carried on in accordance with the act of Congress approved January 29, 1907, which provided "That the Secretary of Commerce and Labor be, and he is hereby, authorized and directed to investigate and report on the industrial, social, moral, educational, and physical condition of woman and child workers in the United States wherever employed, with special reference to their age, hours of labor, term of employment, health, illiteracy, sanitary and other conditions surrounding their occupation, and the means employed for the protection of their health, person, and morals."

The remaining parts of the general report are being completed as rapidly as possible and will each be transmitted at the earliest practicable moment.

Respectfully,

Benj. S. Cable,
Acting Secretary.

Hon. James S. Sherman,
President of the Senate, Washington, D. C.

Department of Commerce and Labor,
Bureau of Labor,
Washington, January 4, 1911.

Sir: I beg to transmit herewith Volume XI of the report on Woman and Child Wage-Earners in the United States, which relates to the employment of women in the metal trades. This is the eleventh section transmitted of the report of the general investigation into the condition of woman and child workers in the United States, carried on in compliance with the act of Congress approved January 29, 1907.

The field work of the investigation of women in the metal trades and the preparation of the report have been done by Special Agent Lucian W. Chaney. The work has been carried on under the general direction and immediate supervision of Chas. H. Verrill.

I am, very respectfully,
CHAS. P. NEILL,
Commissioner.

The SECRETARY OF COMMERCE AND LABOR,
Washington, D. C.

CHAPTER I.

INTRODUCTION.

CHAPTER I.

INTRODUCTION.

METHOD AND SCOPE OF THE INVESTIGATION.

The investigation, the results of which are presented in the following pages, deals with the employment of women in the metal trades. As a very large proportion of women employed in this group of industries are working as machine operators, the study is to a large extent a study of accidents to machine operators in the industries and establishments considered. As in some cases both men and women are employed on machines of the same character, an opportunity is afforded of comparing the liability to accident of men and women under practically the same conditions. For one type of machine especially, the stamping press in its various forms, this group of industries furnishes a large body of data from which the accident liability of men and women working under the same conditions may be compared.

The investigation covered the chief manufacturing centers of the metal trades in the States of Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Maryland, Ohio, Illinois, Indiana, Michigan, Minnesota, Iowa, and Missouri.

In the States enumerated personal visits were made to 348 establishments. For 246 of these detailed information was secured. The remainder were found either to have no employees of the classes under consideration or to be, for some reason or other, irrelevant to this study. The following table shows by industries the number of establishments from which detailed information was secured, and the persons employed according to sex and age groups. It should be noted that paper-box factories are included in this study. This seemed proper for two reasons. One of the machines largely used in box making is of the same type and exposes the operator to the same dangers as the stamping machines used in the metal industries. Furthermore, many of the metal manufacturers make the paper boxes for their own goods, and therefore operate box factories as parts of the manufacturing plants:

ESTABLISHMENTS INVESTIGATED AND NUMBER AND PER CENT OF EMPLOYEES IN EACH SEX AND AGE GROUP, BY INDUSTRIES.

Industry.	Number of establishments.	Number of employees.							Per cent of employees.					
		16 years and over.			Under 16 years.			Total employees.	16 years and over.			Under 16 years.		
		Male.	Female.	Total.	Male.	Female.	Total.		Male.	Female.	Total.	Male.	Female.	Total.
Bolts, screws, etc	13	4,335	1,457	5,792	349	83	432	6,224	69.65	23.41	93.06	5.61	1.33	6.94
Bonnet wire	1	4	30	34	......	......	.....	34	11.76	88.24	100.00	......	......	.....
Bottle caps, etc.	3	298	204	502	......	2	2	504	59.13	40.47	99.60	......	.40	.40
Brass ware	25	11,606	3,033	14,639	124	72	196	14,835	78.23	20.44	98.67	.84	.49	1.33
Corset steels	3	366	1,466	1,832	2	49	51	1,883	19.44	77.85	97.29	.11	2.60	2.71
Cutlery	2	430	50	480	2	......	2	482	89.21	10.38	99.59	.41	......	.41
Electric lamps	1	93	587	680	......	......	.....	680	13.67	86.33	100.00	......	......	.....
Enamel ware	3	303	63	366	......	1	1	367	82.56	17.17	99.73	......	.27	.27
Firearms, etc	2	4,954	2,428	7,382	5	60	65	7,447	66.52	32.60	99.12	.07	.81	.88
Foundries	2	2,681	209	2,890	14	12	26	2,916	91.94	7.16	98.10	.48	.42	.90
Hardware	13	10,780	2,165	12,945	248	89	337	13,282	81.16	16.30	97.46	1.87	.67	2.54
Jewelry	40	3,102	1,735	4,837	49	64	113	4,950	62.66	35.04	97.70	1.00	1.29	2.29
Lanterns	1	234	40	274	......	......	.....	274	85.40	14.60	100.00	......	......	.....
Metal buttons	5	114	212	326	4	3	7	333	34.24	63.66	97.90	1.20	.90	2.10
Metal novelties	9	615	378	993	18	1	19	1,012	60.77	37.35	98.12	1.78	.10	1.88
Metal specialties	9	1,091	360	1,451	22	26	48	1,499	72.78	24.01	96.79	1.48	1.73	3.21
Saws and files	2	2,650	225	2,875	325	43	368	3,243	81.71	6.94	88.65	10.02	1.33	11.35
Silverware	2	236	106	342	2	2	4	346	68.21	30.63	98.84	.58	.58	1.16
Telephones	3	3,640	2,658	6,298	3	2	5	6,303	57.75	42.17	99.92	.05	.03	.08
Tin cans	43	7,969	2,708	10,677	429	111	540	11,217	71.04	24.14	95.18	3.82	1.00	4.82
Tin plate	2	595	44	639	15	......	15	654	90.98	6.73	97.71	2.29	......	2.29
Tinware	4	236	58	294	3	......	3	297	79.46	19.53	98.99	1.01	......	1.01
Type	1	365	75	440	......	3	3	443	82.40	16.93	99.33	......	.67	.67
Wire cloth	2	595	73	668	61	9	70	738	80.62	9.89	90.51	8.27	1.22	9.49
Paper boxes	53	1,716	3,147	4,863	52	285	337	5,200	33.00	60.52	93.52	1.00	5.48	6.48
Miscellaneous	2	31	31	62	......	......	.....	62	50.00	50.00	100.00	......	......	.....
Total	246	59,039	23,542	82,581	1,727	917	2,644	85,225	69.27	27.62	96.89	2.03	1.08	3.11

From the standpoint of number of women employed and the hazard of their employment the tin-can industry, with 43 establishments and 2,819 females employed, is the most important in this investigation. Next should be placed the manufacture of brass ware, with 25 establishments and 3,105 females employed. Others especially significant may be arranged in the following order: Hardware, telephones, bolts and screws, jewelry, etc.

The following table shows the distribution of the more important metal-working industries in the various States included in the investigation and the number and percentage of employees by sex and age. The establishments are grouped according to industries, following, as nearly as possible, the form used by the Census of Manufactures:

ESTABLISHMENTS INVESTIGATED AND NUMBER AND PER CENT OF EMPLOYEES IN EACH SEX AND AGE GROUP, BY INDUSTRIES AND STATES.

State and industry.	Number of establishments.	Number of employees.							Per cent of employees.					
		16 years and over.			Under 16 years.			Total employees.	16 years and over.			Under 16 years.		
		Male.	Female.	Total.	Male.	Female.	Total.		Male.	Female.	Total.	Male.	Female.	Total.
BOLTS, SCREWS, ETC.														
Connecticut...	2	1,073	707	1,780	21	19	40	1,820	56.30	42.26	98.56	1.51	1.37	2.88
Pennsylvania.	1	350	35	385	25	5	30	415	84.34	8.43	92.77	6.02	1.21	7.23
Ohio..........	10	2,912	715	3,627	303	59	362	3,989	73.00	17.92	90.92	7.60	1.48	9.08
Total...	13	4,335	1,457	5,792	349	83	432	6,224	69.65	23.41	93.06	5.61	1.33	6.94
BRASS WARE.														
New York....	7	2,768	1,028	3,796	5	1	6	3,802	72.80	27.04	99.84	.13	.03	.16
Connecticut...	10	5,929	1,691	7,620	88	49	137	7,757	76.43	21.81	98.24	1.13	.63	1.76
Pennsylvania.	1	76	26	102	4	2	6	108	70.37	24.08	94.45	3.70	1.85	5.55
Ohio..........	1	200	17	217	8	17	25	242	82.64	7.03	89.67	3.30	7.03	10.33
Illinois........	5	2,473	239	2,712	5	2	7	2,719	90.96	8.79	99.75	.18	.07	.25
Michigan	1	160	32	192	14	1	15	207	77.30	15.46	92.76	6.76	.48	7.24
Total...	25	11,606	3,033	14,639	124	72	196	14,835	78.23	20.44	98.67	.84	.49	1.33
HARDWARE.														
Connecticut...	7	8,588	1,777	10,365	112	57	169	10,534	81.52	16.88	98.40	1.06	.54	1.60
Pennsylvania.	1	249	76	325	40	12	52	377	66.05	20.16	86.21	10.61	3.18	13.79
Ohio..........	2	1,699	285	1,984	80	20	100	2,084	81.53	13.67	95.20	3.84	.96	4.80
Missouri	2	170	17	187	15	......	15	202	84.16	8.42	92.58	7.42	......	7.42
Illinois	1	74	10	84	1	......	1	85	87.06	11.76	98.82	1.18	......	1.18
Total ...	13	10,780	2,165	12,945	248	89	337	13,282	81.16	16.30	97.46	1.87	.67	2.54
JEWELRY.														
New York	2	278	45	323	4	15	19	342	84.50	11.46	95.96	1.42	2.61	4.03
Rhode Island.	18	1,471	845	2,316	26	14	40	2,356	62.44	35.86	98.30	1.10	.60	1.70
Massachusetts	20	1,353	845	2,198	19	35	54	2,254	60.08	37.53	97.59	.84	1.55	2.39
Total...	40	3,102	1,735	4,837	49	64	113	4,950	62.66	35.04	97.70	1.00	1.29	2.29
TIN CANS.														
New York....	7	1,741	813	2,554	......	......	.....	2,554	68.17	31.83	100.00	......	......	.....
Massachusetts	5	349	85	434	21	9	30	464	75.21	18.33	93.54	4.52	1.94	6.46
Pennsylvania.	4	304	62	366	31	3	34	400	76.00	15.50	91.50	7.75	.75	8.50
Ohio..........	2	375	263	638	20	13	33	671	55.89	39.19	95.08	2.98	1.94	4.92
Michigan	2	380	162	542	40	12	52	594	63.98	27.27	91.25	6.73	2.02	8.75
Missouri	3	239	122	361	1	3	4	365	65.48	33.43	98.91	.82	.27	1.09
Illinois	6	2,056	703	2,759	34	4	38	2,797	73.51	25.14	98.65	1.21	.14	1.35
Iowa..........	1	301	90	391	30	1	31	422	71.33	21.33	92.65	7.11	.23	7.35
Minnesota	1	261	56	317	8	2	10	327	79.82	17.12	96.94	2.45	.61	3.06
Indiana........	2	470	150	620	10	2	12	632	74.37	23.73	98.10	1.58	.32	1.90
Maryland.....	10	1,493	202	1,695	234	62	296	1,991	74.99	10.15	85.15	11.75	3.11	14.86
Total...	43	7,969	2,708	10,677	429	111	540	11,217	71.04	24.14	95.19	3.83	.99	4.81
Grand total..	134	37,792	11,098	48,890	1,199	419	1,618	50,508	......	......	......	......	......	.....

It will be seen from this table that the per cent of women 16 and over employed is highest in the jewelry establishments, there reaching 35.04 per cent of the total employees; in the tin-can factories the woman employees are 24.14 per cent, and the per cent is only slightly less in the bolt and screw factories and in the brass-ware factories. Hardware establishments employed but 16.30 per cent. Very large differences are seen in the percentages when the individual establishments are compared. Thus, one of the large bolt and screw factories had over 42 per cent of women, while another one in the same industry had only slightly over 8 per cent. In practically all of the establishments, however, the women constituted an important part of the working force.

Classifying the data as nearly as possible in the form used in the Census of Manufactures, the following table shows the per cent of children under 16 years of age in the industrial groups considered in this investigation compared with the per cent in similar groups as shown by the Census of Manufactures, 1905:

PER CENT OF CHILDREN UNDER 16 YEARS OF AGE EMPLOYED IN INDUSTRIES COVERED AT CENSUS OF 1905 AND IN ESTABLISHMENTS INVESTIGATED IN 1907-8.

Industry.	Per cent of children of total employees.	
	Census, 1905.[a]	Establishments visited, 1907-8.
Brass ware	1.95	1.33
Iron, steel, and products[b]	.99	4.26
Jewelry	2.04	2.29
Total, all industries	2.92	3.11

[a] Special Report of Census Office, Manufactures, 1905, Part I, pp. lxxv, lxxviii, 116, 276.

[b] In this group the census includes the manufacture of pig iron and of steel, and all finished products, while the present investigation includes establishments manufacturing only the smaller products, mainly those made by machines.

This table shows that in the specified industries the establishments included in the investigation used a slightly higher proportion of young workers than was found in the entire group in 1905, though much below the specially child-employing industries.

The adoption of a shorter workday in Ohio for the women between 16 and 18 is still too recent to show much influence. Whether the employment of women above 16 has undergone any marked recent change in the industries studied can not be determined from the data at hand. The general tendency is reported to be toward their increased employment. The girl of 16 and upward has, according to superintendents and foremen, to a considerable extent replaced the boy under that age in these industries. Among the reasons given for this change are the following: The girl of 16 is more mature than the boy of the same age. She is steadier and more reliable, and in earning and saving is usually more ambitious. The boy of 16 is often averse or positively unwilling to take up the sort of tasks which have hitherto fallen to the younger boy and are now passing in no small degree to the older girl.

Another consideration has weight with employers in making the girl above 16 preferred to the boy under that age. At that age the restrictions cease; permits and school certificates are no longer necessary. Better service and lessened responsibility for the employer with little, if any, added cost cause the girl above 16 to replace her brother under that age in many tasks.

The displacement of the boy has one serious disadvantage. When boys worked at these tasks, it was possible to pick out the clever and ready, who might be expected to become leading men and foremen. The girls do not furnish material for this purpose. Either the boy above 16 must be attracted by higher pay or special methods must be adopted for the training of boys for these positions. This at first unforeseen development will, in the view of many superintendents, check the tendency to replace boys with girls in many of the lighter occupations.

LAWS AFFECTING THE CONDITIONS OF EMPLOYMENT OF WOMEN AND CHILDREN

The States in which this investigation was carried on include those in which the most careful attention has been given to legal enactments governing the employment of women and children. As a foundation for a clear understanding of the conditions, a brief statement will be made of the portions of the law which apply to those engaged in metal manufacture. The statement relates to the time of this investigation in 1908.

AGE LIMIT.

In all the States included, except Maryland, employment is illegal under 14 years of age. In Maryland, 12 years is the legal minimum. In Missouri, the restriction does not apply outside cities of 10,000 or over. In each State employment under 16 years is illegal without a permit. These permits or employment certificates are of various forms in different States and are issued by various authorities. As a rule, they certify the age, the school attendance, and the ability of the child to read simple English sentences. These permits must be kept on file by the employers and must be produced upon the demand of any proper authority.

HOURS OF LABOR.

In the States in which the investigation was made night work in factories is prohibited to employees under 16, save in Connecticut, Indiana, and Maryland. The period within which such employment is unlawful is greatest in New York, where it extends from 5 p. m. to 8 a. m. The shortest is from 10 p. m. to 6 a. m., or 9 p. m. to 5 a. m. This prevails in several States. Connecticut, Indiana, and Maryland have no law upon this subject, and Pennsylvania makes an exception of cases where perishable material might suffer damage or when the factory is operated in day and night shifts. Iowa excepts canning factories.

In Ohio the working day for all children under 16 and for girls under 18 must not exceed eight hours. The week must not exceed forty-eight hours. Illinois and New York provide that the hours of labor must not exceed forty-eight per week for those under 16, the latter State prescribing as the hours of beginning and closing 8 a. m. and 5 p. m.

Missouri permits nine hours per day, fifty-four in one week.

In Massachusetts,[a] Rhode Island,[b] and Connecticut ten hours in one day, fifty-eight per week are lawful.

Maryland and Michigan allow ten hours per day, sixty in one week.

Indiana permits ten hours per day, sixty in one week. If a short day is made at the week end, the hours may be increased in earlier days.

Iowa does not limit hours except as above stated for night work.

Minnesota permits ten hours per day and sixty per week, with no provision for shifting to make a short day.

Pennsylvania permits not to exceed twelve hours in one day, sixty in one week.

LEGAL PROVISIONS AGAINST INDUSTRIAL DANGERS AND DISEASES.

ELEVATORS.

The operation of elevators is prohibited to persons under certain ages as follows: Connecticut, to persons under 16 years; Illinois, under 16 years; Massachusetts, under 16 years, or if the elevator runs more than 100 feet per minute, under 18 years; Michigan, under 14 years; Missouri, under 14 years; New York, under 15 years, or if the elevator runs 200 feet or more per minute, under 18 years; Ohio, under 16 years; Pennsylvania, under 16 years.

MACHINES.

Illinois was the first to put in effect a series of specific prohibitions in regard to employment on or around machinery. As other States have adopted the Illinois law, or closely followed its provisions, the part applicable to workers in metal is quoted entire:

> No child under the age of 16 years shall be employed at sewing belts, or to assist in sewing belts, in any capacity whatever; nor shall any child adjust any

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[a] In 1908 the Massachusetts law was modified for those under 18 and for women providing that the hours must not exceed fifty-six per week, except in seasonal occupations, where the week may extend to fifty-eight, but the average for the year must not be over fifty-six.

[b] In 1909 Rhode Island reduced the number of hours permitted in one week to fifty-six.

belt to any machinery; they shall not oil or assist in oiling, wiping or cleaning machinery; they shall not operate or assist in operating circular or band saws, wood shapers, wool [wood] jointers, planers, sandpaper or wood-polishing machinery, emery or polishing wheels used for polishing metal, wood turning or boring machinery, stamping machines in sheet metal and tinware manufacturing, stamping machines in washer and nut factories, operating corrugating rolls, such as are used in roofing factories, nor shall they be employed in operating * * * any steam boiler, steam machinery, or other steam generating apparatus * * * wire or iron straightening machinery; nor shall they operate or assist in operating rolling mill machinery punches or shears * * * nor shall children be employed in any capacity in preparing any composition in which dangerous or poisonous acids are used * * * nor shall they be employed in * * * any other employment that may be considered dangerous to their lives or limbs, or where their health may be injured * * * nor shall females under 16 years of age be employed in any capacity where such employment compels them to remain standing constantly.[a]

Ohio and Missouri have, with slight variations, the same law as Illinois. In Missouri the law applies only in cities of 10,000 and over.

The Michigan law prohibits cleaning machinery while in motion and employments dangerous to health and morals for males under 18 years and for females under 21; it also prohibits the operation of polishing wheels and belts by women.

New York prohibits cleaning machinery while in motion for males under 18 and females under 21, and specifically prohibits for males under 18 and for all women the operation of "emery, tripoli, rouge, corundum, stone, carborundum, or any abrasive or emery polishing or buffing wheel, where articles of the baser metals or of iridium are manufactured."

Pennsylvania prohibits children under 16 years from cleaning or oiling machinery while in motion.

Rhode Island requires the special permit of the factory inspector to allow a child under 16 to clean or oil moving machinery.

All the States of the list except Maryland have general prohibitions of occupations dangerous to life or limb or likely to be injurious to health.

SEATS FOR FEMALES.

Each of these States requires that seats be provided for female employees and that they be permitted to use them sufficiently to safeguard their health or when not engaged in the active duties of their occupation. This provision, so far as relates to the use by the employees, is difficult of enforcement and is largely a dead letter.

EXHAUSTS AND FANS.

Connecticut requires suitable installations for buffing and grinding wheels and for dusty occupations. The provision that such installation shall not interfere with the business or operations makes possible much evasion.

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[a] Acts of 1903, Illinois, p. 187, sec. 11.

Illinois and Michigan have laws making very specific requirements regarding size of pipes, power of fans, and other points of this sort.

Maryland requires exhausts in mills which grind flint.

Missouri makes it discretionary with the factory inspector to require exhausts for smoky and dusty rooms.

Rhode Island has no law on this subject.

In the other States the laws are couched in general terms, requiring exhausts from buffing and grinding wheels and other dusty occupations.

The effectiveness of such requirements depends entirely on the interpretation and enforcement given them by the inspection service. Since few inspectors care to go beyond the letter of the law, the results are far from satisfactory. Many installations, which may once have been efficient, are now scarcely useful at all.

GENERAL VENTILATION AND LIGHT.

Rhode Island is now the only State included in this study not having some specific enactment in regard to ventilation and light. Since, however, with a few exceptions, these enactments simply prescribe an inadequate minimum of space per occupant they accomplish little.

In New York a law requiring a certain space for each worker and that it be kept ventilated is, under discretion granted the commissioner of labor, producing acceptable results.

The present (1909) Illinois law was not in force at the time of the investigation. It is the first measure to embody in the law itself really adequate provisions relating to ventilation.[a]

GENERAL SANITATION.

The provisions regarding dressing rooms, separate water-closets, etc., are substantially uniform and will be brought out in the later discussion.

ENFORCEMENT OF LEGAL PROVISIONS.

In all the States included in this study the factory laws are under the administration of bureaus designated somewhat variously, but each essentially a bureau of factory inspection.

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[a] See Bulletin of the Bureau of Labor, No. 85, pp. 547, 548.

CHAPTER II.

GENERAL FACTORY CONDITIONS.

CHAPTER II.

GENERAL FACTORY CONDITIONS.

CONSTRUCTION OF BUILDINGS.

Of the 239 establishments in metal and paper-box manufacture for which data on this point were secured, 18 occupied frame buildings, 7 had modern buildings entirely of concrete, and the remaining 214 were mainly brick, with an intermixture of frame and concrete structure. The frame buildings were for the most part found in smaller cities and villages, where they stood more or less isolated and to that extent with diminished risk from fire. Eighteen, 7.53 per cent of the whole number, were so poorly constructed, so dilapidated, and with stairs so worn and unsafe that they presented conditions of extreme danger from fire and other peril.

The buildings varied from 1 to 12 stories in height. In the single case where a building of 12 stories was in use it was a fireproof structure with an admirable system of fireproof stairways and other provisions for safety and comfort. The average height of buildings in use was 2.39 stories, and the average height at which employees worked was still less, since many of these factories occupied single floors in buildings with stories above them.

The custom regarding use of elevators was so varied, some part of the force having opportunity of use which was denied to others, that any statistical statement of value is impossible. It is proper to say that the frequency of low buildings and the use of elevators allowed to women and children in the higher buildings remove any reasonable ground for asserting that there is marked hardship in the labor involved in reaching their places of occupation.

EXITS AND FIRE ESCAPES.

The chief question which must be asked regarding the loftier factory buildings is their safety in case of fire or panic from other cause. The situation disclosed by the investigation is not wholly reassuring. The facilities in many establishments are clearly inadequate for exit or escape in case of emergency.

The best standards with reference to exit or escape in case of fire recognize three things as practically essential: First, adequate fire escapes with unobstructed access; second, an automatic sprinkling system; third, such an arrangement of the working force as will avoid crowding in the upper stories and admit of ready exit in case of danger.

In thirteen cases buildings three or more stories in height were wholly unprovided with fire escapes. In all of these the fire hazard from the character of the building was considerable and in some unusual. Inquiry seemed to indicate in these cases that some peculiarity of situation had contributed to oversight by the inspectors. In one State escapes are not regarded as necessary upon a three-story building.

The automatic sprinkler system is perhaps a more important protection than the fire escape. A complete record was not made in this particular, and probably the one hundred and five establishments in which its presence was noted were not all in which it is to be found.

The third precaution suggested, namely, so adjusting the working force as to insure the least possible danger of a crush and panic, does not seem to have received the attention it deserves.

This view is emphasized by the blank surprise with which questions regarding the number likely to use a given escape in case of fire were invariably received. The fact seems to be that many, if not most, escapes have been designed to fit a law, when they should have been adapted to a condition. Calculations indicate that very frequently the numbers whom a given fire escape would naturally serve, could not possibly pass down in a reasonable time, and further that if all of those who would naturally seek that escape were to crowd upon it, the strength of the structure would probably not be equal to the strain. Enough was observed to justify the assertion that the means of safety must be adapted to the number who must use them if the shocking disasters of the past are not to be duplicated. There may be records of actual tests of the capacity of fire escapes in given situations, but inquiry fails to reveal them. Grave question also exists regarding the appropriateness of the design most frequently used. In even a mild panic it is entirely possible that these escapes would prove traps rather than means of safety.

LIGHT AND VENTILATION.

These topics are properly treated together, since, as a rule, the provision for a natural supply of the first exactly measures the possibilities regarding the second.

The standards in regard to both light and ventilation in many States are most primitive. Light enough for the worker to see the task upon which he is engaged, and if it is not perfectly convenient to furnish a natural supply, the installation of some artificial illuminant, often insufficient in quantity and ill judged in arrangement; this seems to be too often the rule of procedure.

This judging the adequacy of natural light solely by its relation to vision is one of the most unscientific things of which the industrial constructor is guilty. The value of fresh air and sunlight as specifics for many forms of disease, especially tuberculosis, is fully recognized, but their importance in the factory and workshop do not seem equally well known. It is fortunately true that the demands of vision have led to the building of many modern factory buildings with their walls "all windows." Even these, however, err seriously sometimes in making the space inclosed so large that even the plenitude of windows fails to light up the dark central spaces. Natural light is quite as important for its germicidal power as for its aid to vision. Were vision the only or even the main concern, our sources of artificial light would serve the purpose, but none of these have the disinfecting power which makes sunlight so valuable.

Seventy-three out of 239 establishments from which information on this point was secured had insufficient light from the visual standpoint, much more so from the standpoint of disinfection. The remaining 166 concerns ranged from those having, by a combination of natural and artificial means, enough for working purposes to those whose windows were abundant, well-arranged, and clean. The number belonging to the highest class is very considerable, the new shops are almost invariably an improvement on the older, and many of them are all that could be desired.

Of the 237 establishments from which information as to the air supply was secured, in 18 a complete system of ventilation was found, while 109 were provided with some mechanical means for ventilation. Aside from these, 110 establishments were without mechanical means for ventilation, 94 having only windows, and 16 having windows with some skylights. Applying to these establishments such standards as are usually adopted by law or in the practice of factory inspection, 70 had less than 250 cubic feet of air per worker and in addition were using gaslights during the day. In 167 establishments the air space per worker amounted to 250 cubic feet or more.

It will be observed that 127, or 53.6 per cent, have provided some means for ventilation other than the so-called natural system. While no tests could be made of much real significance, it is now generally recognized that no factory room with any considerable number of occupants can be adequately ventilated without the use of power to bring in the needed air. In the complete systems mentioned above, most of which would stand a rigid test and some of which would go beyond any standard anywhere in use for factories, the air is warmed by steam pipes and forced into the rooms by fans. These fans can be and are used to force the air into the factory during the season when heat is not required. This accomplishes the supply of needed air and at the same time helps the temperature conditions. Too much stress must not be laid upon the number of places where mechanical ventilation has a foothold. It is often confined to some one portion of the buildings and was installed for another purpose. The removal of dust and fumes was often the prime object, the provision of air being an incident not regarded by the employer as important.

REMOVAL OF DUST AND FUMES.

This subject is closely allied to that of ventilation, since the presence of these dangers hastens the results which arise from impure air, and the recognized method of removal assists or may, in some cases, replace what may be called strictly ventilation.

The occurrence of metallic dust in grinding, buffing, and burnishing, and in tumbling rooms, and of acid and volatile oil fumes in dipping, plating, and lacquering, are so nearly universal in one form or another in metal manufacture that a tabular statement of the places visited does not seem to be required. These dangers are so obvious that they have attracted attention and secured remedial action out of proportion to their relative importance. It is not too much to say that had general ventilation and lighting been brought to their best possible estate, and the special problem of dust and fumes entirely neglected, except as involved in the general problem, the average results upon the workers would be in advance of what we now have. This does not in the least lessen the importance of dealing with these latter problems, but illustrates the constant emphasis which must be put upon the fundamental, as well as upon the exceptional and obvious.

Comparatively few women and children have to do with the dusty occupations of the metal trades. The dry grinding of cutlery is not much practiced in this country, and of the wet process much is now transferred to machines which may be tended by girls, but which have no element of danger. Two States exclude women from buffing rooms where the baser metals are polished, and except in one or two localities, the sentiment of the women or that of the men in the occupation, prevents their large employment. For example, in the Providence and Attleboro jewelry shops, in an inspection sufficiently extensive to have encountered almost certainly the practice had it existed, no women were found engaged in polishing.

So general is the recognition of the serious effects of metallic dust and so thorough the work of State inspection that but one establishment was found where the exhaust apparatus prescribed by law was not installed. In a large number of cases, however, the design was faulty, the fans not powerful enough, or they were so old and worn as to largely nullify any excellence the apparatus may ever have had. In a few cases young boys were working in an atmosphere heavy with brass particles which, with bad general ventilation and poor light, must subject them to tuberculosis and possible death before they attain their majority.

A particularly pleasant side to this picture, however, which must not be forgotten, is the great number of such rooms which are well lighted and pleasant, and which have efficient machinery, kept in perfect order and doing its work with thoroughness.

The rooms devoted to operations which produce injurious or irritating fumes were without exception provided with some special arrangements for their removal. Either the work was carried on in a separate building, a single story in height with free opening above, or was located in the top story with similar arangement of the roof, or, more commonly, some arrangement of exhaust fans was adopted. Grades of efficiency from the entirely worthless to what seemed perfect in action were observed.

The engineering of many installations is at fault, and not a few must have been erected by those capable enough in the mechanical side but having very limited engineering knowledge.

The proper proportion of the parts of the system to secure equal draft throughout, the joining of the lateral branches at a proper angle to the main trunk, and fans of adequate capacity to handle the load without undue use of power, were all seen in apparent perfection, and systems were also seen where inattention to these points rendered a well-intended expenditure practically useless.

In the occupations involving exposure to fumes, described more in detail under the individual industries, a considerable number of women and children are employed. The supervisory positions are occupied by men, but the handling of the articles preparatory to the processes is for the most part done by young women and boys. In lacquering brass and in enameling a large number of operators are women. Since these workers are much more susceptible than adult males to the depressing influences of such conditions, their presence affords added reason for insisting upon the apparatus being brought to and kept at the highest efficiency.

GENERAL SANITATION.

The nature of the work carried on in many of the metal-working establishments makes quite difficult the maintenance of that general cleanliness which is to be desired. This difficulty seems so great to a large proportion of superintendents and foremen that they give up or never undertake the effort. After a brief period of relaxed vigilance in this particular the difficulty seems absolutely prohibitive. That the difficulty is not insurmountable is shown by instances in each industry where the untoward conditions have been mastered and a satisfactory degree of cleanliness secured and maintained.

The first essential to general cleanliness is light. When the untidiness is revealed by proper lighting, its undesirability is forced upon the attention and is to that extent likely to be remedied. It is not possible here to discuss methods of factory cleanliness beyond suggesting the advantage of vacuum cleaning in factories. The great advantage of the method is the removal of germs without chance of dispersal.

The provision of adequate toilet rooms has received much attention from factory inspectors, in the States included in this study, with good results. Only three cases were noted during the investigation where separate provision for the sexes was not made. Rating these provisions in five grades, they classify as follows: Excellent 63, good 65, fair 57, poor 16, bad 12, not reported 24, total 237. In the excellent class were placed those rooms in which the plumbing was of good modern pattern, the floors of cement or tile or carefully constructed of wood, and cleaning was so frequent and careful that even suspicious inspection would not disclose offense in odor or appearance. In the bad division are the few which were in a condition of positive filth.

In 35 cases the air of the workrooms was affected in degrees varying from slight odor in the vicinity to a nauseating pollution extending for many yards.

The sharpest criticism which can be directed against these provisions is the neglect of proper privacy. In a few cases it was possible to see the interior from a point in the shop. In a still greater number of cases the demands of economy in the matter of plumbing had dictated the placing of the rooms for the sexes side by side and no care had been taken to make privacy of approach possible. This was true even in States where the law specifically requires that adequate screening be provided.

DRESSING ROOMS AND WASH ROOMS.

The following statement shows the number of establishments which, in addition to toilet conveniences, provided dressing rooms and wash rooms:

Establishments providing dressing rooms for—	
Males	17
Females	64
Establishments providing wash rooms for—	
Males	45
Females	71

It is evident that the special needs of female employees are receiving attention to a very considerable degree. The disparity between the numbers given above and the total number of establishments visited (237) shows that further progress is possible and desirable. It was particularly noticeable in a number of cases where women work with paints and enamels containing lead that the washing facilities were not what they should be. In all occupations involving lead the most scrupulous cleanliness is imperative, since the greatest danger to such workers arises from eating with hands soiled with any of the lead preparations.

LUNCH ROOMS.

The opportunity of taking food comfortably at the noon hour deserves more attention than it has usually received. Only 8 establishments were found making special provision for this. The significance of this is lessened by the fact that probably a majority of work people in these industries do not take the meal at the works, but so many do that a provision of a suitable place may reasonably be asked.

The time allowed at noon in these establishments averages 51 minutes, only 7 concerns restricting the time to the minimum of 30 minutes.

HOURS OF LABOR.

There is much variety in the method of adjusting hours of labor, and this is further complicated by arrangements regarding overtime which are peculiar to the individual establishments. The hours of child labor are always the same as for older workers, unless some definite provision of law prevents. Two reasons are advanced for this rule: First, that the child's work often accompanies or underlies the occupation of an older worker in such a manner that when the child's work ceases the work of the older persons must cease also. Second, that the child who comes late or departs early from the factory is seriously exposed to the contamination of the street. This second reason is present in the minds of some employers in perfect good faith, but there is so ready an intrusion of interest at this point that its presentation must be viewed with caution, amounting to suspicion. It is further alleged that the presence in the factory of a group of workers having a different working day from the majority tends to demoralize the working force. It seems probable that the result of enforcing a different working day for children is to diminish the number employed, but the point is not yet conclusively established. Some study was made of the situation in Illinois, where the law has been in force for some years, and of New York and Ohio, where the change is more recent. Unfortunately, the financial disturbance which was current during the time of the investigation affected results in a way impossible to disentangle from the effects of these laws. The view to be taken of the restrictive effect will depend on the standpoint of the observer. The expression of one superintendent has some significance. He said:

> At present this restriction does not affect us in the least, but later when business revives it will mean that we must employ men and pay more.

The table which follows exhibits the facts regarding the hours of a working week in 238 establishments.[a]

HOURS OF EMPLOYMENT PER WEEK OF MEN, WOMEN, AND CHILDREN.

Working hours per week.	Males 16 and over.			Females 16 and over.			Children under 16.		
	Establishments.	Employees.		Establishments.	Employees.		Establishments.	Employees.	
		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.
48	1	60	0.10	3	346	1.52	10	115	4.43
50	1	27	.05	3	119	.52	1	3	.12
51½	....	....	....	2	429	1.89	....	....	....
53	4	106	.19	12	739	3.25	8	61	2.35
53½	2	278	.49	2	249	1.09	2	19	.73
54	37	16,059	28.17	39	5,601	24.63	20	550	21.19
55	34	5,539	9.72	33	2,839	12.48	17	504	19.42
55½	....	....	....	4	355	1.56	....	....	....
56	6	1,133	1.99	9	735	3.23	3	13	.50
57	14	1,822	3.20	12	907	3.99	4	25	.96
58	24	2,658	4.66	38	1,688	7.42	17	194	7.48
58½	3	285	.50	3	124	.55	....	....	....
59	71	17,894	31.39	44	6,002	26.39	24	289	11.14
60	41	11,135	19.54	29	2,612	11.48	24	822	31.68
Total	238	56,996	100.00	233	22,745	100.00	130	2,595	100.00

The table shows how the movement for shorter hours has affected these metal-manufacturing establishments. The full 60-hour week is still the practice of a little over one-sixth of the establishments and applies to an almost identical fraction of the employees. Below this the factories fall into two groups: (1) Those having the 10-hour day, with varying concessions in early closing on Saturday. This group includes from 55 to 59 hours per week. (2) Those having a working day of 9 hours or less. This group includes 54 hours per week and under.

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[a] Five of these employed no women and 108 no children.

Comparing the hours of men, women, and children, the results are as follows:

PER CENT OF MEN, WOMEN, AND CHILDREN WORKING EACH CLASSIFIED NUMBER OF HOURS PER WEEK.

Classified hours per week.	Per cent working each classified number of hours.		
	Males 16 and over.	Females 16 and over.	Children under 16.
Under 55	29.00	32.90	28.82
55 and under 60	51.46	55.62	39.50
60	19.54	11.48	31.68

It will be seen that practically one-fifth of the men, as against something under one-eighth of the women work the full 60 hours a week and that proportionately more women than men are found in each of the groups working less than 54 hours.

The situation shown among the children is unexpected. It is true that the number employed, as compared with the adult workers, is small, but the proportion working 60 hours a week is nearly three times as large as among the women and over 60 per cent more than among the men. This situation is due to a few large establishments which employ an unusual number of this class of employees. These establishments are, of course, not in Illinois, New York, or Ohio, where the legal limitation of children's hours is already in effect.

CHAPTER III.

DESCRIPTION OF INDIVIDUAL INDUSTRIES.

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In the preceding pages the endeavor has been to set forth the general facts regarding work and workers in metal manufacture. It is now in order to present in an entirely nontechnical way the features of each industry as they bear upon the situation of women and children.

The industries will be presented in alphabetical order, with such fullness as the importance of each in this investigation may seem to demand.

BOLTS AND SCREWS.

The joining of these as one industry is only partly justified by the similarity of the product. The machines used are quite different. In bolt making the forge shop plays an important part. Here boys under 16 are quite frequently employed, usually as helpers, though in rare instances they have more important duties. Many bolts are made with square heads for convenience in using a wrench. It is found convenient to forge the majority of these round and then trim them to the square form in a strong press. The bolts are frequently fed to this press by women, and in doing this considerable risk is run of injury to the hands. In one shop a device was observed which consisted of a chute, into which a girl fed the bolts at a distance from the moving parts. As this machine can do the work at considerable increase in speed, it may be that in time it will supersede the other method.

The production of a thread upon a bolt is accomplished mostly in two ways. For the production of a deep thread a special form of lathe is used. To prevent heating and to facilitate the action of the cutter a stream of oil or of water in which sodium bicarbonate is dissolved is directed to the action point. Water would serve without the alkali, except that rusting is prevented by its presence. These threading machines are often tended by women. There is no special hazard, but the work is rather unpleasant, since the oil and the alkaline water saturate the clothing. Constant moistening of the hands with the alkali tends to produce cracks and irritation, which may become severe. The nut-tapping machines, operated by women, have the same difficulty.

For many forms of bolts the threads are formed by a roll threader. This consists of a stationary plate and a movable one. The latter is moved by a suitable mechanism, and a bit of wire rolled between the two plates has the thread impressed upon it by grooves in the dies. The motion is exactly like that of rolling a pencil held upright between the palms of the hands. Feeding this machine is often done by young boys and girls. It is a simple process and devoid of danger if the machine be properly constructed. The later patterns are fed automatically from a hopper, which reduces the number of attendants and practically eliminates danger.

The assembling of the larger sizes of bolts and nuts is done by women and, beyond being severe on the hands from the roughness of the articles, is not dangerous. The smaller sizes are largely handled by boys. They sit at steel-covered tables. In the edge opposite each boy is a shallow depression the bottom of which is formed by a rapidly revolving disk. The boy pushes a nut into the depression, applies the tip of a bolt to the opening, and in an instant the nut is whirled on the bolt.

Some manufacturers are now doing away with this practice by using extra care in production so that they are willing to guarantee the ready fitting of the parts. They send out the separate parts in bulk, saving themselves an operation and the users the necessity of removing the nuts from the bolts before use.

The manufacture of wood screws is almost entirely done by automatic machines too complicated to admit of description here. Women are largely employed in three occupations connected with this manufacture: First, as tool grinders; the tool is held in place and has only to be advanced by the worker, with practically no chance of injury. Second, as tool setters, who place the tools in position in the machines; this involves some shifting of belts, which is always a dangerous operation. Third, as feeders, who attend several machines and see that the screws do not clog as they pass along the chutes to the action point. Accidents occurring in this occupation are properly chargeable, as a rule, to the operator and are very few.

The other operations in which women are employed are in the nature of inspection, assorting, packing, etc., and are devoid of hazard.

A few nail and tack mills were studied. In these practically no employment of children was found. Women work as sorters of nails and in the tack factories attend the machines. In the making of tacks rather thick steel plates are used. These after pickling in acid are treated with a cream of lime. This dries upon the surface and serves as a dry lubricant and prevents rust. These plates are cut into long flat rods by a powerful cutting press, which is sometimes operated by young women. The rods are then conveyed to the machines, where the operator attaches them to a mechanism which by means of weight moves the rod forward endwise toward the strong jaws by which tacks are bitten off and formed. The width of the rod gives the length of the tack. Between bites the flat rod is turned over. This reversal gives the taper to the tack, first in one direction, then in the other. Since the operator has no occasion to approach the working parts, there is little danger.

BOTTLE CAPS.

These are made from tinfoil and from light sheet tin. In the tinfoil caps, presses are used in which a series of processes are performed. The young women supply the pieces at one end and the machine carries them from die to die, each adding its modifying touch. None of the processes can be considered dangerous. In the coloring and enameling materials used, which are applied mostly by women, some lead is present, and since there is constant contact and since cleanliness before eating is not always enforced, the chance of lead poisoning is certainly present.[a]

The stamping machines used in making tin bottle caps are of the dangerous type and so far as observed no attempt has been made at even the simplest guards. In making cork-lined caps, on the other hand, ingenious automatic machines fed with metal strips and sheet cork turn them out completely finished in quantity, with no danger to the operator.

BRASS WARE.

The products under this head are various, but fall mainly into two groups, cast brass and sheet brass. This distinction is mainly one of convenience, since the occupations in the two branches overlap and no sharp distinctions can be drawn. For the purposes of this inquiry there is one notable difference, namely, in cast brass work the employment of women is very small and of children still less. The women are found mainly in the core rooms. In all hollow cast ware the space which is to be hollow is occupied by a mass of sand molded into the desired shape. The sand used is of a special quality and is worked slightly moist. It forms a plastic, though friable, substance easily taking the desired form. As a rule, the girl who works at core making sits at a long table divided into separate compartments for each worker. She grasps a quantity of the plastic sand and forces it into the metal mold before her with the fingers. The mold is usually in two pieces. When one portion is firmly filled the other part, commonly held in place by pins which enter holes in the first portion, is adjusted. Pressure with the hands or sharp blows with a small mallet force the sand into the finer details. The cores thus formed are carefully placed in trays and introduced into a drying oven. These ovens are sometimes so constructed as to throw off much heat into the room, and the abnormal temperature resulting is a menace to health. In the best form of the ovens this defect is almost entirely obviated. The rooms where the work is done are almost of necessity well lighted, and, except for the high temperature and the occasional proximity to the casting room from which injurious fumes penetrate, are not objectionable.

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[a] It was not possible either here or elsewhere to follow carefully possible danger from lead poisoning. This danger has been carefully studied in England, and taking their experience as a guide, we must strongly suspect harm to workers exposed to this metal even when distinct symptoms are not seen. The subtle nature of the undermining effect, the cumulative character of the poison, and the easy access to other disease conditions afforded by the lowered vitality incident to the effects of lead all combine to render more or less dangerous any occupation into which it enters.

In the casting rooms men are usually employed, and occasionally a boy under 16. These rooms are usually in one-story portions of the factory or on the top floor. Monitors and skylights in the roof are the rule. This is in recognition of the danger of the occupation. Whenever a pouring occurs, a dense white cloud arises from the molten metal. This consists of deflagrated zinc and produces various untoward results. Brass founder's ague is a distinct and well-known occupational disease. The name suggests a character which is not wholly in accord with the facts, since the disease may occur with no aguish symptoms. Thorough ventilation and a plentiful use of milk seem to be the only safeguards. In the matter of ventilation the use of mechanical means is rare and deserves further consideration, since in the best of casting rooms the brass founder is still exposed to serious danger.

Outside the core rooms women were not found in brass foundries, except in a very few instances in buffing and in packing the goods for shipment. That the employment of women on buffing wheels and other polishing apparatus is not favorably regarded is evidenced by the fact that the States of New York and Michigan positively forbid such employment. The objections are two: First, the metallic dust to which women are even more susceptible than men; and, second, the occupation, as a rule, requires constant standing. That such employment is unsuited to females on anatomical grounds is the opinion of physicians.

So far as metallic dust is concerned, it is possible to make that danger so small as to be negligible. The other condition can not be obviated, in many instances, and must remain a permanent objection to this form of employment for women.

The making of articles whose basis is sheet brass affords opportunity for a much larger employment of both women and children.

The work of women and children varies greatly from establishment to establishment. Each establishment has developed for itself a method of utilizing its working force. It may be said in general that the commonest employment of women is upon some form of stamping press, drill press, or riveter.

The description of a typical large establishment affords the readiest means of presenting a picture of the facts. The concern chosen employs no children, but has 203 women out of a total of 866 employees. The buildings range from the 1-story casting and annealing room to the 5-story buildings, well supplied with windows. A high iron fence extends along the street, between which and the front of the buildings is a well-kept lawn.

The approach to both the office entrance and that used by employees has some flower beds, and the whole air of the place is cheerful and attractive. The suggestion of good light afforded by the numerous windows is borne out by the interior conditions, except in a few rooms where it is necessary, even on ordinary days, to reinforce the natural illumination by electric light.

Some large power presses, operated by men, could be much more perfectly guarded than is at present the case, at no excessive expense.

The occupations in which women were occupied were as follows:

(1) Core making: This occupation has already been described.

(2) Attending automatic machines: These machines take a piece of brass and moving it from point to point mold it by successive operations into the desired form. In tending these machines, the operators had only to keep them supplied with blanks, and to stop them if, in the progress of the operation, anything went wrong. After the last operation a blast of air was utilized to remove the completed piece from the dies.

(3) Assembling: In this occupation women take the completed parts of an article, in this case a bicycle pump, and with various hand tools, adjust and fasten them together.

(4) Operating foot presses: These presses are some of them adjusted to deliver a sudden blow, while others afford a slower and more powerful pressure. The quick acting are necessarily more hazardous. The accidents are probably as numerous, but much less severe than upon the power press.

(5) Operating a power screw driver: Some of the articles have a number of screws to be driven and a machine has been devised which does this very expeditiously.

(6) Operating riveters: These machines strike a series of sharp blows. In some of them the wire is fed to the machine and the rivets are cut off and formed during the process. This exposes the operator occasionally to the danger of getting the finger into the machine and having the wire thrust through the finger. The noise of a group of these machines is rather trying to unaccustomed ears.

(7) Operating power presses: A varying number of women operate these presses. The records show a large number of accidents upon this machine. The guarding could be made very much better.

(8) Lacquering: Most of the workers apply the preparation with a brush. The solvents used are of a volatile character and the air of the room becomes quite irritating. Ventilating fans in the walls do much to alleviate this condition.

(9) Soldering: The workers are seated at benches running along the walls under windows. Usually a little gas stove serves to heat the soldering irons. The work is light and not unpleasant. The fumes of acid used as a flux and the emanation from the gas furnaces make special precautions regarding ventilation desirable. An exhaust fan in the wall was fairly efficient. An occasional burn from acid and heated solder is a small hazard which can hardly be avoided.

(10) Work in nickel-plating rooms: In the room where nickel plating is going on the women work as handlers. The work itself is light and easy, but the presence of acid fumes makes precautions necessary, and the arrangements for their removal are frequently inadequate. The objectionable fumes should be caught near the point of origin and when they are allowed to escape into the room, removal by general ventilation or special fans only partly relieves the objectionable condition. In the factory under consideration the tanks used in the plating process had no hoods or other means of prompt removal. The fumes were not acutely noticeable, but prolonged work in the room could not be otherwise than injurious.

(11) Work in the dip room: In the dip room a few girls work in stringing up the articles and in other light operations. The sinks where the acid fumes are given off have hoods through which the fumes are effectually disposed of by means of exhaust fans. The operations which expose the hands of the worker to corrosive action of the acids used are here and elsewhere usually performed by men. But one exception to this rule was observed during the investigation.

(12) Work on special machines: In this, as in other factories, certain processes are performed on machines of special design adapted to a particular process. None of these have features of special hazard. For this reason, and because without illustrations an intelligible account is impossible, no attempt will be made to describe these machines.

The foregoing represents with reasonable fullness the employments in which women and children were found engaged in the manufacture of brass ware. The particular establishment is one conducted on good lines. The care shown in safeguarding machines is not up to the highest standard, but is above the average. The general shop conditions would be entitled to rank with the best observed, designated, where the attempt to classify has been made, as " excellent."

CORSET STEELS.

The machines operated vary somewhat in the different establishments. In some the whole process, including the tempering of steel ribbons, is carried on, while others receive their material partly worked.

In the tempering and galvanizing rooms there are fumes. In galvanizing, the fumes are decidedly injurious and special devices are in use for their removal. These devices were not, in the observed cases, wholly successful, but since the employees are usually men, with only rarely a boy under 16, no extended attention was given to the matter.

Machines operated by females or boys and affecting their condition were observed as follows:

(1) An automatic machine for cutting steel ribbon into required lengths. This requires attention to prevent clogging, but with proper care should not be dangerous.

(2) An automatic machine to which the operator feeds the steel strips, and in which paper is folded and fastened about the strips.

(3) A similar machine which binds the papered strip with a metallic binding at the end. In most cases the strips have to be passed through the machine twice to complete the operation.

(4) In one establishment a detached building was used solely for a process of covering the steels with a coating of cellulose. The inflammability of this substance makes the precaution of a separate building desirable.

(5) Rivet presses: The older forms of these presses require the placing of the rivets with the fingers, and, although the action of the press is by the foot of the operator, accidents are frequent. The newer forms are power driven and have feeding devices which lessen the opportunity for accident. One form was of special interest since it required the touching of a key to release the machine and permit it to act.

(6) Power presses.

(7) Foot presses.

(8) Shaping machines by which the steels are bent into the desired form.

(9) Japanning rooms: In some cases women placed the steels in the carriers by which the dipping in the liquid japan was accomplished.

(10) Tumbling barrels: This method of brightening metal pieces where many of similar size and form are made is of very general application. The metal objects are placed in revolving receptacles and the rubbing of the pieces together breaks off roughness and polishes the articles. Various substances may be put in with the

metal objects, such as sawdust, leather scraps, etc. If the process is carried out, as it can be in some cases, in the presence of water, there is no evolution of dust. Much more frequently the results desired require that a dry method be used, and much metallic dust is given off. Unless some method is adopted of removing this, it may become a source of serious injury to the small number engaged in these rooms. In the cases observed, the barrels used were of wood or metal, truncated cones in shape, the smaller end uppermost. The barrels revolve on a somewhat inclined axis. Opposite the mouth of each barrel was placed the funnel-shaped terminus of a tube connecting with an exhaust system. In this way the dust ground off by the rolling of the metal articles one upon another was immediately captured by the stream of air and carried away. Methods of collecting and disposing of all dust will be described further on in connection with industries in which it is more notably developed.

CUTLERY.

The number of women and child workers in this industry is, so far as observed, very small. The grinding, confessedly the serious menace, is in the hands of men. In one establishment women fed into small planers the strips of wood used in the making of handles. The dust arising was carried away at once. Aside from this, almost the only employment of women was in packing and inspecting the goods before shipment.

ENAMELED WARE.

In some establishments women operate presses, but for the most part this work is given to men. The dipping of the ware is almost exclusively in the hands of women. It is not difficult work and requires a certain deftness which girls acquire more readily than boys.

From the nature of the work the general conditions in factories devoted to this process drop below the desirable standard. There is also one danger which may be present but could not be demonstrated in the course of this investigation. The manufacturers naturally do not care to disclose the composition of the dip used, as each has his special formula. It is known that at times lead has been an ingredient, but no recent analyses are available. The women who work in these establishments are not cautious regarding cleanliness of the hands before eating, and in some cases proper facilities for washing are not provided. This makes it possible that harmful reception of lead may take place. It should be clearly understood, however, that sufficiently recent data are not available to warrant positive statements.

FIREARMS AND AMMUNITION.

It may seem rather remarkable that this industry stands fifth among those studied in the number of women employed. This is due to the extremely varied employments necessary to the construction of a modern gun, but especially to the fact that the making of metallic ammunition affords many light tasks suited to the strength and ready dexterity of woman.

In the manufacture of the guns themselves, women workers were found employed as follows:

(1) Polishing gun barrels: In one establishment a large, high-ceiled upper room was devoted to this purpose. In two rows down the room extended the tables at which the girls sat. Before each one was a rapidly revolving wheel to which she applied the barrel until it shone like a mirror. At each wheel was a hood, and carefully designed tubes connected each hood with powerful and efficient exhaust fans. The room appeared so free from dust that an especial effort was made to test its condition in various ways, with no indication of the presence of any metallic particles whatever. This occupation was apparently free from any danger. Some accidents had occurred in former times from the hair of the operatives being drawn in by the air current. As a result, the company requires those employed in this room to cover the hair with a net. Since this rule went into effect no accident has occurred.

(2) Inspection of gun barrels: This inspection is for flaws in the treatment of the surface. These flaws may be either in imperfect polishing or in some failure to color properly. The women become very expert and pick out at a glance imperfections which are hardly apparent to the untrained eye even when pointed out.

(3) Inspection of parts of locks: This is exacting work, since the inspector must note and reject imperfect parts for the most trifling error. The system of measurements is so rigid that a part too large or too small is almost unknown, but a roughness which would seem of no possible significance is detected and the part discarded.

(4) Assembling locks: In this occupation we might naturally expect to find the experienced male artisan. In some special designs this is the case, but for the regular patterns women are employed and become very expert.

The making of ammunition affords a very much greater variety of occupation than the manufacture of guns. To follow the processes by which a metallic rifle cartridge is produced will give an idea of the nature of these occupations. From sheets of brass of appropriate thickness, hemispherical cups are cut and formed by powerful presses. These presses are, so far as observed, always operated by men. The cups are subjected to successive drawings upon presses provided with automatic feeding devices. The result of the operations is to transform the shallow cups into elongated cylinders with rounded bottoms. The shells are then put through a machine which flattens the rounded bottom and forms the flange, which in rim fire holds the fulminate, and in both rim and center fire rests against the edge of the firing chamber and keeps the shell in place. In many rifle cartridges the mouth of the shell is formed into a narrow chamber, which holds the bullet. This forming process is done on a special machine. During these processes the shells are moistened and lubricated with soapsuds.

One result of the drawing of the metal is to make it more or less brittle. To correct this the shells are passed through a special annealing machine.

Since this has a special feeding device much used in these processes, it will be more particularly described here. The operator sits at the machine and before her at a convenient height is a horizontal disk revolving at varying rates of speed in different machines, never rapidly. Upon this the shells are placed, standing on the closed end. As they move forward with the progress of the disk they are carried into the space between two strips of metal which extend over the upper surface. At first widely separated, these strips approach each other until along the back of the disk they form a lane about a foot in length just wide enough for the shells to pass in single file. In the annealing of shells gas flames are directed upon them during this portion of their transit. The lane terminates at the margin of the revolving plate, and the metal cylinder drops into a receptacle below.

The device is modified to suit different circumstances. There may be depressions in the surface into which the part to be modified is fitted. As the disk revolves the pieces are put in place by the operator at one margin while the action of the machine is occurring on the other side.

As will be explained later (p. 61), even with this device it was found necessary to put extra safeguards upon the machine to prevent the instinctive efforts of the operator to rectify occasional faulty action.

All operations involving explosives are conducted in separate buildings with every possible precaution against accident. It is outside this investigation to describe these devices, but it is appropriate to say in regard to them that recent years have seen exceedingly important progress.

For some of the processes of the loading house women are well adapted. Few are employed there, but those few are exposed to a very grave danger from the use of mercury in the form of fulminate. Even under the best conditions the employees have to be secured by test. Some are so susceptible to the influence of the mercury that they can not even be engaged about the room, though not coming into contact with the deleterious substance. Evidently the emanations which pass into the air, though not immediately irritating enough to be called fumes, are a serious menace to health. The careful selection of those who are to some degree immune and a supply of perfectly fresh air make the occupation tolerable. In one establishment there was installed about five years ago a very efficient ventilating system, in which the air is washed and tempered and then delivered near the floor by pipes distributed so as to flood the entire room. To illustrate the effect of this change, the superintendent stated that before this system was adopted the foreman, who did not handle any of the material, was often obliged to give up work for months at a time. After the ventilation was improved, the foreman found that the characteristic symptoms of his ailment almost entirely disappeared.

The making of cartridges for shotguns presents many features of interest, but the metal-working features do not differ essentially from those already described, and the other occupations present no feature of special hazard.

FOUNDRIES.

This industry employs women in the core rooms, as already described, and has a few boys as helpers. These latter are more or less exposed to the danger of burns from the hot metal, but their number is not large nor the hazard great. Under these circumstances, it is not necessary to go into further details except at one point. The use of tumbling barrels to polish metal parts is almost universal and the metallic dust evolved is often troublesome. This is the case in the room where the barrels are situated, but even where the removal has been provided for the final disposal is still a problem. Various collectors are in use, the commonest being that called a cyclone. It consists essentially of a large funnel-shaped receptacle often located on the roof. Into this the stream of air coming from the exhausts is delivered tangentially near the top. The whirling stream is slackened in its speed and its load of dust is largely deposited. These are efficient when the amount to be cared for is small. In foundries the amount is often so great that a cyclone is simply overwhelmed and the plant smothered in escaping dust.

Two new devices have come under observation during the investigation which seem adapted not only to tumbling rooms but to other dusty processes. Both these depend on passing the dust-laden air through a screen of cloth.

In one the screens are in the form of cylindrical bags, which are arranged in a radiating fashion about a horizontal axis. These cylinders revolve about the axis and the air is forced into them during most of the period of revolution. When a given line of cylinders reaches the point vertically above the axis, an ingenious arrangement causes the air current to be reversed and to be drawn into the bags from the outside. At the same moment rubber-faced hammers are set into action and, striking the frame, cause a sharp vibration. This reversal of the air and vibratory action combine to empty the bags of their dust. As they pass on, the current changes again and another set reaches this emptying point. The machine was seen in action only in a flax mill, but it is used and has proved efficient in many other situations.

The other device is essentially a closed chamber divided into two parts by a very zigzag partition of cloth. The dust-laden air coming in on one side must pass this screen to escape. A vibrator is set in motion at intervals and causes the dust to fall into hoppers below, from which it can be removed at suitable intervals. This is usually done once a day where the tumbling barrels are in constant use.

HARDWARE.

So varied are the products coming under this head that it might be separated into several. The problems are much the same in all plants, and for this reason and for convenience the subject will be considered as a single unit.

First, a large establishment will be described, followed by special discussion of some points not illustrated by its processes.

The establishment in question employs 2,591 people, of whom 2,091 are males and 437 females 16 years of age and over. Twenty-nine boys and 34 girls are also on the pay rolls. There are 25 buildings, varying from the rolling mill, which is one story high, with a gallery along the sides, to a new eight-story structure of concrete faced with brick. In the entire plant there is evidence of care. The buildings are well located with reference to each other and to the railroad which runs through the plant. Throughout there is a system of automatic sprinkling and the fire escapes are better than the law requires, though a panic test of them might show that they are barely adequate.

In this, as in the majority of the larger metal-working plants, the incandescent electric light has very largely replaced gas. In most parts of the plant the illumination, natural and artificial, is adequate for visual purposes, but many parts of the factory do not receive the needed disinfection by sunlight. A considerable body of workers, for example, are steadily employed in basement rooms never reached by sunlight.

An interesting method of heating is in use. A turbine pump forces heated water through the radiator pipes in all parts of the plant. The rapidity of the circulation is easily adjusted by a change in the engine, and the engineer sets this speed governor according to temperature and wind conditions. The result is a very uniform and pleasant heat throughout the establishment.

For the general ventilation the reliance is upon the generously abundant windows. Only careful tests would accurately measure its adequacy. The size of the rooms gives a full allowance of space in accordance with the standards usually adopted, but this is often a misleading test in actual operation. The special installations for the grinding room and the plating room are of good design and efficiently operated.

The arrangements of toilets are of excellent character. Dressing rooms are provided for both men and women and the adjacent closets are carefully kept clean and free from unpleasant odors.

In the rolling mill, a very large and open room, cold rolling only is done. The hot rolling is done in another plant in another city. In this mill, at the main plant, a very few boys work as helpers. Their occupations expose them to few dangers.

The following machines were observed in operation attended by women or children:

(1) Spinners which flatten and round off the ends of butt pins. Little danger attends this operation, since the hands of the operator do not come near the action point. In some patterns of the machine a special device prevents action if any foreign object is caught in with the pins.

(2) Reamers by which the interlocking parts of a butt or hinge are reamed out so that they will fit accurately. Not dangerous.

(3) Stamping presses with feeding stacks into which the blanks are fed. This method removes any possibility of accident.

(4) Stamping presses which lock so that action is impossible during the adjustment of the article.

(5) Stamping presses fed by hand, protected by finger guards. These are dangerous. The finger guard, as used in this factory, is not a perfect protection.

(6) Staying machines in the box factories. These are operated with a guard attached to the machine and the steel finger cot upon the finger. Since the adoption of the latter no accidents have occurred.

In the plating room women handle the articles and attach them to the bars by which they are carried to the solutions. Such rooms are often pervaded by acid fumes decidedly irritating to the air passages. In this case a well-built wooden hood, above the apparatus, catches the fumes as they rise, and they are carried away by a powerful suction fan.

Besides those enumerated above, several forms of machine were seen operated by women in other establishments, in which some danger exists. For example, in some drill presses and punch presses, danger is not absent. Usually in a drill press the drill is brought down to the work. In several factories a modification was noticed, interesting because it removed, to a degree, the chances of accident. In these the work is raised against the drill. The beginning of this movement would afford a warning to the operator which might prevent serious results.

In saddlery hardware, a chief element in the production is harness buckles. The bending of the tongue of the buckle around the bar which holds it in place is done upon a special press. The original practice was to use a press into which the operator put the buckles, one at a time. The press ran constantly and the operator must acquire a rhythm corresponding to the action of the machine. Such a situation is one certain to produce accidents, since any disturbing circumstance is sure to break the rhythm and the dissociation may produce harm. Two methods which avoid this complication are in use and bid fair, for many sorts of work, to take the place of the single-tonguing machine. In one of these newer machines the buckles are placed upon holders at the edge of a revolving disk. The revolution then carries the buckle to the action point, and there is no need to bring the hands near to it. In the other machine the buckle and tongue are separately fed into the machine which then automatically brings them together and completes the process.

In several of the factories the cleaning and scratch brushing of the goods is done by women, and in nearly all they are engaged with paints, enamels, or lacquers. The presence of lead or of irritating volatile solvents makes these processes undesirable for women, and calls for extreme care in the matter of cleanliness and ventilation.

JEWELRY.

This industry, so far as it materially affects women and children, is much concentrated. This made it possible, in a comparatively brief time, to study with some care quite a large number of establishments. In a very large proportion of the jewelry factories investigated the general conditions are excellent, better, in fact, than in any other branch of metal manufacture included in this investigation.

The establishments which make solid goldwork employ, in the manufacturing processes, men almost exclusively. The burnishing and polishing may be done by women, though in most localities the prejudice against this employment is strong both among the women themselves and among the male polishers. Since there is recovery of sufficient gold from the process to be an important item, the polishing wheels are always, so far as observation goes, equipped with efficient exhausts kept in good running order. In the localities where what is usually termed "roll plate" is manufactured there is a large employment of women. In ring making they may operate the bending machines, but as a rule they do bench work in assembling and soldering the various articles.

The basis of "roll-plate" goods is "flat stock." Bars of gold with silver solder interposed are clamped to thicker bars of brass. These compound bars are placed in a furnace and heated to a temperature such that a perfect union results. These bars are then rolled into sheets or drawn into wires, the relative proportion of gold and brass remaining constant. By means of presses, this stock is shaped into such form as may be desired. These die-made forms are soldered together, usually by woman workers. Boric acid is used to prevent a change in color. The pieces are then usually pickled in sulphuric acid of varying strength, which removes the boric acid and prepares for "coloring." After polishing with cotton-cloth wheels, the piece is dipped into a solution of potassium cyanide and gold. This gives a thin coating of purer gold, intensifying the color and bringing out the design more sharply.

Hoods and exhausts are in nearly universal use with all acid baths and the removal of fumes is usually entirely satisfactory.

METAL BUTTONS, NOVELTIES, AND SPECIALTIES.

The general fact to be noted regarding these industries is that women are largely occupied in processes involving the use of stamping presses, either power or foot. The guarding of the presses is less careful and efficient than in the other lines discussed. The number of the presses is less than in other industries, so that the total of accidents is not large but the proportion is rather high.

In the manufacture of the needles used in sewing machines for shoes nearly all the processes are performed by automatic machines tended by women. These processes evolve a large amount of metallic dust, necessitating the use of ducts and exhausts. The most exacting detail is the formation of the eye of the needle: Steel wire is clipped into proper lengths by a machine to which the wire is fed automatically. These bits of wire are first pointed. A worm feed pushes the needles forward to a cylindrical emery wheel, by which a point is quickly formed. From this point the processes are controlled by the form which the needle is to have. A curved needle requires a machine for each step, while a straight needle may be formed on a machine which presents the piece of metal to a series of tools, each working some detail.

Two forms of machines for straight needles were seen in operation. In the first an endless belt carried a series of clamps. When a clamp arrives at a certain point a bit of pointed wire drops from a stack and is pushed by a plunger into the clamp. The belt then moves forward and brings the pointed wire to the first tool. The first one cuts a notch, which forms the beginning of the eye. The belt moves on and a second tool flattens one side of the point. A third tool works out a spiral groove extending from the notch forming the beginning of the eye down to the point. The next shift brings the needle to a swiftly revolving wheel, which, moving in a curved path, finishes the forming of the eye. Another move forward and a pair of jaws grasps the needle, pulls it from the clamp, and drops it into a pipe by which it is carried to a reservoir. It will be understood that the processes mentioned in succession are being performed simultaneously on the series of needles.

A newer machine for the same series of operations carries the needles to the tools upon the margin of a revolving disk.

Other grinding processes are performed by rapidly moving belts which have an abrasive surface, or by strips of abrasive cloth held in the hands of the operator. This industry is peculiar in that it presents the case of women working at an occupation having danger from metallic dust. So far as observed, these factories have an efficient system of exhausts and the dust is perfectly removed.

SAWS AND FILES.

The making of these products involves quite different processes, but in a number of cases the same concern made both. For this reason they are considered together.

In the making of saws certain of the woodworking employments are assigned to boys, such as smoothing the handles upon endless belts, covered with an abrasive. This process evolves much dust and no suitable provision for its removal was observed. Girls work at varnishing and are exposed to the irritating fumes of the solvents.

In operations upon saw blades boys were observed attending the machines by which the saws are set. These require the saw to be held firmly, but present little opportunity for accident. Both boys and girls wipe off the blades. The lime used to prevent rust easily flies and the inhalation of the dust must be quite injurious. It is also irritating to the frequent wounds and scratches which come from the teeth of the saws. In the packing room, where young women are mainly employed, there is also chance of these wounds, which from their character are more likely to become infected than clean cuts. Almost as much care is necessary to prevent infection as in brass making.

The old process of cutting files required artisans of special skill. They used a bed of lead, upon which the metal blank rested, and each tooth of the file was formed by a chisel driven by the stroke of a hammer. To produce uniform teeth required much skill and long practice. Much danger of lead poison was present, since a dust of lead arose from the beds and might be inhaled, while the hands became covered with the lead dust which without extra cleanliness would be introduced in the taking of food.

This hand method of cutting is still in use for making files for special purposes and is attended by the dangers enumerated above. The majority of files, however, are now produced by the use of machines. The relation to our group of employees will be best indicated by following the process from step to step:

The steel bars come from the rolling mills in 6 or 8 foot lengths. Lime is used in preparing them, acting both as a lubricant and a preventive of rust. Men attend the machines by which the bars are cut into appropriate lengths and are formed into shape. Boys are employed in carrying the material and supplying it to the men, but were not observed running the machines. The tangs of the files are then forged by means of a small trip hammer. A few boys under 16 are promoted to this work, being employed upon parts which do not demand the highest skill. The heat and somewhat vitiated air of the forge room make this a trying occupation for a boy, but danger of accident is not great.

The annealing of the file blades is, so far as disclosed, done by men exclusively.

The blades are put through stripping machines which remove the roughness from them and prepare for cutting. The stripping machines are very often attended by women. When the files are put in position, there is a chance that the hand may be caught between the end of the file and the holder. If this occurs, a severe punctured wound may result.

The cutting machines are attended by women and boys. No young girls were noted. The machines require to be fed with the blanks and started, the actual process being then carried on by the machine itself. The chief danger of this occupation is metallic dust, which is present in the air to a sufficient extent to constitute a real menace.

TIN-FOIL.

This material is made in two forms. Pure tin is required in the wrappers used upon chocolate and other moist articles where the foil comes in direct contact with the material. Recent food laws have excluded lead from use for such purposes. The second form of foil consists of a lead sheet with a thinner covering of tin on each side.

Both tin and lead are cast in blocks about 8 by 12 inches and 1½ to 2 inches thick. These ingots are then rolled into sheets. At a certain stage the tin sheets are applied on each side of the lead and the further rolling compacts them into a continuous mass. This kind of foil is used with a paper lining for making cigarette and tobacco wrappers. The employment of women in connection with this manufacture is only in handling the completed foil. The printing of labels is done on ordinary presses and on a special form of rotary press. They have the usual dangers. In the earlier processes there is some exposure to lead, but it is probably not very serious. Only among casters have serious conditions been observed.

TIN PLATE.

The work of women in American factories manufacturing this product seems to be much less severe than those described as prevalent abroad. In some plants women "openers" pull apart the sheets of metal after rolling. This occupation calls for the exertion of considerable strength and the piles of plates which must be handled and carried tax severely even those accustomed to hard labor.

So far as observed machinery has supplanted in American works the hand labor of women which formerly was applied in washing and cleaning plates preparatory to pickling. Since women often work in the same rooms where these processes are going on and the fumes must affect them to some degree, it is desirable to describe the processes. The plates are blue mottled with brownish shades. They are placed on edge in crates or cages, which depend from arms extending radially from the top of a revolving post. Parallel bars at the top of the cage keep the sheets from contact with each other. There are three of these cages. While the third is receiving its load of plates the others are swung by the revolution of the supporting post into position over vats containing, first, a hot acid solution and, second, constantly changed clean water. By the action of a plunger the cages are raised and lowered into the liquids. By this use of acid, followed by clean water, the scale, grease, etc., is removed from the plates and their color changes from the blue mentioned above to a dull uniform gray.

The plates as removed from the carrier are placed upon trucks, care being exercised by covering them with cloths to prevent drying, since a spot becoming dry refuses to take the tin properly. The lighter sheets intended for making tin cans are carried by rolls down through a flux of melted rosin into a bath of pure tin. The rollers carry the sheet forward and finally upward. The last rolls through which it passes are kept flooded with hot palm oil. Rather heavy fumes arise during this process, which are carried off in part by a stack of brick above each set of rolls. In spite of these special vents and of monitors in the roof, the air of a tinning room frequently becomes very heavy. The fumes are not in themselves especially injurious, but prolonged work in such an atmosphere can not be otherwise than depressing.

The light tin sheets mentioned above are placed as they come from the bath in a rack, from which an endless belt removes them and passes them through sawdust, by which the surplus oil is removed. Bran is sometimes used for this process, and this is described as a very dusty process. The "branning" is often done by girls.

Light-weight roofing tin is made in similar fashion, the coating material being a mixture of lead and tin.

Heavy roofing tin made by what is termed the "old-style" process requires more prolonged treatment and an instinctive skill on the part of the worker only gained by long practice.

Three men stand before the wide mouth of a stack like an old-fashioned fireplace. The baths of oil and molten metal fill this, coming about the height of an ordinary table. The chief worker at the right takes the sheets one at a time from a trough of water and drops them into a bath of hot palm oil. The regulation of temperature is an important matter and depends upon the instinctive knowledge of the workman. When the sheets have acquired the proper temperature they are removed to another bath adjacent, having below the melted tin and lead and above the hot palm oil. The second workman takes the sheets from this bath to a second of similar character. The third workman dips a sheet at a time into a third bath of molten metal and into a last bath of hot oil. The last workman transfers the plates to a girl, who makes a quick inspection for conspicuous defects and transfers them to a system of rolls, by which, with the aid of sawdust automatically renewed, the oil is removed.

After the tinning the plates go to the inspectors and counters. So far as observed these are always women, with rare instances of girls under 16. None of the processes except that performed by the openers are severe. The women in the tinning room are subjected to an atmosphere certainly not wholesome, and at some seasons the temperature must be unnaturally high.

TIN CANS AND TINWARE.

So many of the processes of these industries are involved in making the common cylindrical can used in packing fruit and vegetables that a description will be given in some detail. In the most complete factories the machines are arranged in what are called lines of machines.

First, scoring machines cut the sheet tin coming from the mills into the size desired for the particular can. Men usually operate these. Second, the strips of tin from the scorers are placed in the hopper of a forming machine. The slips pass one at a time to a device which bends them into a cylinder, forms the joint, and presses this firmly down in one operation. As the can body leaves this a flux is brushed upon the joint and a line of solder applied. This is fused under a gas flame and the can body is complete. Third, the body passes to a vertically revolving, wheel-like ending machine, which is usually tended by a woman. Near by stand presses provided with dies so arranged as to cut out at each stroke an equal number of tops and bottoms. The can bodies are secured in appropriate grooves in the margin of the ending machine. Two chutes extend to it from a platform above, and into these boys or girls feed the tops and bottoms which drop into position at the lower end of the chutes as the can body reaches a certain point in its revolution. At the next position tools quickly spin the tops and bottoms fast to the body. The cans then drop from the machines upon a low table, on each side of which sits a young girl, whose business it is to detect any imperfect placing of the can ends. All such imperfect pieces are picked out by the girls and passed to a boy who sits near and fits on perfect tops or bottoms as the case may be.

Fourth, the cans pass to a soldering machine by which the tops and bottoms are soldered in place. As the cans pass along in this machine men inspect them and remove those which are imperfect. At the end of this machine is a series of brushes which remove loose particles of solder from the outside of the can. This process produces considerable metallic dust, which in the best factories is removed by covering the brushes with a hood and applying an exhaust. Fifth, from the soldering machine, conveyors take the cans to the testers, usually attended by women. These testers vary in pattern, but are all essentially wheels revolving either vertically or at an angle, so that at the lowest point the wheel dips below water in a reservoir. The cans drop from the conveyor into their places on the periphery of this wheel. At this point air under about 8 pounds pressure is forced into the can, and immediately the movement of the wheel causes a rubber plug to press firmly over its mouth. As in the further revolution of the wheel the can passes below the water, any leakage is at once made evident by the rising of bubbles. When this happens the attendant turns a little lever and the imperfect can drops into one chute, while the perfect can passes on to another. The passage of the can from point to point is accomplished by elevators and rollways. Often the cans pass from the last machine directly to cars for transportation.

In the making of other forms of cans and tin articles the use of presses for stamping out and forming the parts is a constant source of danger. In lithography and japanning irritant solvents are used whose fumes are trying and, unless proper precautions are used for their removal, do no little damage. The presence of lead in some of the preparations employed has its usual hazard.

The table on page 86 shows the dangers incident to this class of manufactures. The study of 60 establishments (p. 73) shows that it has a higher accident rate among its adult workers than any other industry included, while the table on page 76 shows that in individual establishments its accident rate among women is very high. It should also be said that the employers in this industry have shown considerable anxiety to discover and willingness to use such safeguards as will lessen the risk of these employments.

TYPE FOUNDRIES.

The employments of women are mainly in inspecting, assorting, and packing the type. One or two machines were seen operated by them by which a portion of the type body was cut away, or some other small detail worked out. Such machines give rise to metallic dust and were, in all observed cases, provided with hoods and exhausts for carrying away the dangerous product. In the handling of the type some dust is given off, which may be inhaled and some of which will of necessity adhere to the hands. As in all such cases ample provision for washing, with rigidly enforced rules regarding the taking of food, are essential to the safety of the workers. The industry presents many features of interest, but they seem to affect men exclusively.

WIRE CLOTH.

Women are employed both as loom tenders and in sewing the webs of cloth together in making the endless sheets used by the paper manufacturers. In shuttle looms, where the shuttle is thrown, as in cloth weaving, the flying out of the shuttle occurs occasionally. The speed of operation is less than in ordinary weaving and the danger correspondingly less. What is called the "positive action" loom removes this danger. In this, bars which have a clutch at the end are thrust alternately through the warp. The clutch grasps the shuttle and as the bar retreats the shuttle is drawn through, leaving the strand of wire in place. These looms can not work so rapidly as those with thrown shuttles, but the larger number which can be attended by one worker compensates for the lower speed.

Almost the only danger which seriously menaces these workers is the likelihood that small cuts on the hands may give rise to serious inflammation. Special care is necessary, particularly where the cloth is made of brass or bronze wire.

PAPER BOXES.

The general factory conditions are the serious matter in this industry. The work is often carried on in the lofts of city buildings, where the conditions of light, air, etc., may be anything but satisfactory.

Accidents occur in this industry chiefly on two machines. First, the box ender. In this the ends of the boxes are placed in a reservoir at the top of the machine. A plunger rises from below upon which the box is placed. As it reaches the upper limit of its excursion the glue is applied and the end is slid into place. At the limit of movement the box is pressed with great force against the end. The action is not very rapid, but from time to time a finger or thumb is caught and crushed. Second, the corner stayer. In this the box is so placed that one corner fits over the corner of an anvil. A mechanism at the back of the machine glues a strip of paper and moves it forward. At this point a plunger descends from above with a sharp blow which cuts off an appropriate length of this strip, which it wraps around the corner of the box, stamping it firmly into place.

It will be seen that the action of this machine is much like that of stamping presses used in metal manufacture. Its dangers come in two ways. The strip sometimes does not come forward properly. When this occurs operatives reach beneath the plunger and pull the strip forward with the fingers. Most manufacturers furnish a pair of pliers for this purpose. These are sometimes chained to the machine, since otherwise they are very easily lost or misplaced. The second source of danger is in handling the box. As the plunger makes its movements the operator revolves the box from corner to corner. If the rhythm of this action of the hands becomes even slightly dissociated from that of the machine an accident is likely. The makers have endeavored to safeguard against this, but for reasons given in the section on accidents the device is often discarded by the workers. That the reasons advanced for so doing are not entirely sound is shown quite clearly in the facts there presented.

CHAPTER IV.

DANGERS OF INDUSTRIAL EMPLOYMENT.

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DANGERS OF INDUSTRIAL EMPLOYMENT.

Under this head are included not only the risks of injury from accidents but also the risks to health arising from the conditions under which an industry may be conducted. The chief perils encountered by the workers under consideration are grouped around the following factors: First, the supply of air; second, the presence of poisonous or irritating fumes; third, contact with poisonous materials; fourth, exposure to unnatural temperature or degrees of moisture; fifth, machinery.

The question of ventilation is of great importance. The standards established in various States are of little significance, since owing to local conditions one establishment which conforms strictly to the requirements may be wholly bad, while another not complying may be quite commendable. So little scientific observation has hitherto been given the subject that it must be passed, so far as the present investigation is concerned, with simply the statement that its importance demands thorough study. One outcome of such a study will certainly be a conviction of the need for a sanitary inspector, equipped with apparatus enabling him to distinguish with a degree of certainty good ventilation from bad, and equipped also with expert knowledge of the problem.

The other forms of industrial danger enumerated above are present in some metal-working establishments in a way to affect women and children. Since, however, some of these are not common dangers, but are found one here, another there, they have already been considered in the descriptive treatment of the individual industries.

One danger is found in all metal-working establishments—the machine. It will be profitable to assemble in this place the facts regarding this danger to the worker. In the consideration of the statistics of accidents will be found concrete evidence of the importance of this subject.

Before taking up in some detail the subject of danger from machines, a few facts should be recalled regarding the development of industry. Into modern machine production intrude two factors practically unknown to those household industries from which our present factory system has developed—the nervous strain of working at a pace set by machinery, and the deadening monotony of performing only one operation in a highly subdivided process.

As the effect of these factors has become evident there has been an increasing demand for relief. The wearing away of natural resistance is made evident by the increasing occurrence of cases of nervous exhaustion among workpeople.

This situation reenforces the demand for reasonable and effective safeguards.

CARELESSNESS AS A CAUSE OF INDUSTRIAL DANGERS.

In the reports of industrial accidents which in certain States are required by law, nothing is more striking than the frequency with which "carelessness" appears under the heading "Cause of accident." There is a general and deeply rooted impression that by the exercise of due care the worker can avoid the larger part of the dangers to which he is exposed, and that in consequence if he is injured it is very apt to be his own fault. In view of this, it is worth while to examine closely some of the causes usually classed as carelessness, in order to see how far the worker is really responsible for them.

A power machine worker must, for the sake both of safety and efficiency, become automatic. Only with freedom from the strain of performing each act by a conscious exercise of will come skill and comparative safety. The faltering learner is in constant danger. Not only are his movements apt to be awkward and imperfectly coordinated, but the very intensity of his care is in itself a source of danger. Strained attention leads to action by anticipation. A common laboratory experiment illustrates what is meant by such action. The subject of experiment may be required to do some act—press an electric key for example, upon the appearance of a prescribed signal. Intent upon executing the movement promptly upon the appearance of the signal, some entirely different nervous stimulus may set off the nervous system and the key be pressed. This stimulus may be an unexpected noise, or any other occurrence which applies a spark to the train of nervous activities.

An athlete crouching, tense, at the starting line may be sent from his mark by a sudden gust of wind. In such a case, the starter must, for purposes of discipline, act on the assumption that the act was voluntary. In the great majority of cases it is not voluntary in the smallest degree. A tense nervous system is always liable to be set into action by some other than the regular stimulus.

This fact applies very directly to the learner upon a machine. Many things conspire to create for him a condition of tension. Knowledge that the machine is dangerous, anxiety to show ability equal to the task, and many other causes act upon the beginner, who is quite likely, as our industry is organized, to be youthful.

The acts of the operator must come in proper relation with those of the machine. The beginner, unskillful yet, waits tensely the position of the machine which signals the making of his contribution to the process. At such an instant there intrudes some other stimulus, it matters not what. He anticipates his movement. Mangled fingers, a lost hand, or greater mutilation may result.

This would certainly be attributed by any foreman in any factory to the "carelessness" of the victim. But is it so? A normally organized nervous system has done what it must under the circumstances and disaster results.

It should not for a moment be forgotten that this sort of action of the nervous system is a foundation of its usefulness. A system incapable of such behavior would also be incapable of executing those amazing protective actions by which life itself is preserved. The operator is as powerless to prevent such action as he is to prevent the machine from going its appointed round. As practice continues, the tension gradually subsides and the worker attends less closely but is vastly more safe. The operator may look at other objects, may speak with a companion, or do other things which indicate that attention is no longer concentrated to so painful a degree upon the work. At the same time, the rhythmic movement of the hands keeps up and the output of the machine continues. This condition is often described as one of "carelessness." The term is altogether misleading in this connection, since it implies that the worker is taking a risk in a blameworthy fashion. In becoming thus, in a measure, detached from the work, the worker does the only thing which can relieve the relatively great danger which assails the beginner. He has reached a condition of automatism which, except under conditions specified later, is greatly safer than his earlier situation, when, as a learner, he was attending with exactness to each item of the process.

This release of the worker from the beginner's slavery to minute detail is important, from the standpoint of his safety and even more from that of his nervous health. The routine of attending a machine involves strain enough at the best. If the degree of attention necessary at the outset continued through any extended period, the strain would be destructive. This is the more true, the higher the original quality of the nervous system concerned. For a normally constituted person such a continued strain would be impossible without grave damage.

The trained, and hence automatic, worker is not wholly free from accident. What of the factor of carelessness in his case? As suggested above, there is nearly always an implication that the operator might, by greater care, escape many if not all of the dangers which beset his occupation. A thoughtful consideration of the preceding discussion must lead to the conclusion that for the beginner, at all events, this is far from true. Further we must agree that escape from the beginner's danger lies along the road to a condition which many observers of work people would call "carelessness." The very attitude which is charged with causing accident is seen on closer analysis to be an effective means of safety.

In the case of the trained worker, danger intrudes at two points, at neither of which can he be said to sustain a responsible position toward the result. A very large number of mechanical processes involve a series of operations, one following another. For example, in the operation of a stamping press, the adjustment by the fingers of the object to be formed is followed by a movement of the foot upon a releasing treadle. At first these successive actions are a result of attention on the part of the operator to each item of the process. There is complete demonstration that this period is one of the greatest danger.

Gradually the two motions assume a relation of direct cause and effect with no intervening volition. One follows the other with the same certainty that the fall of a stone follows the removal of the support. Suppose the worker has reached this stage of his development. Some roughness on the work, some failure of the machine to do its part exactly may delay or disturb the first motion. It is evident that the first motion being interfered with, the execution of the second may, probably will, give rise to danger. Having started the action, can the worker, when the first motion goes wrong, refrain from the second? So far as his will entered into the matter, it was in the form of a command for the whole action, comprising the successive motions. It may even be doubted whether the will enters so much as that, but it is certain that once started the successive motions are beyond his control. The first starts the second. The worker is helpless.

Another disturbance of the usual progress of events may occur through the special senses. Suppose that the worker has started his series of movements. These, as we have noticed, must go on through their regular sequence. After the series starts, he sees something amiss with work or machine. This may, usually will, start an entirely new series of actions, but does not stop the one already started. Here again comes in the inevitable movement of a nervous machine. In an entirely involuntary way he reaches to readjust the disordered work. It is almost certain that the two series of actions will cross each other. He will press the treadle and at the same moment put his hand under the die.

This will appear as carelessness, but it can not fairly be so considered. Both machines, the human and the nonhuman, did what they must.

A concrete case may help to make the situation clear. In the manufacture of cartridges several operations are performed by drawing presses. These are usually fed by means of a horizontal revolving disk upon which the operator places the cartridge shells. The rotation of the disk carries them through a gradually narrowing lane, formed by metal strips, to the action point. Very strict orders were given in one factory to stop the machine if any of the shells toppled over or went wrong in any way. Nevertheless it was repeatedly found that good and experienced operators, acting upon the spur of the comparatively rare occurrence of improper action, would reach to adjust a toppling shell, become entangled, and be badly hurt. Finally, the superintendent arranged a screen with a little swinging door through which the shells passed on their way to the drawing dies. This made it necessary, if anything happened needing adjustment, to stop the machine in order to attend to it. This illustration is cited not only as an example of the automatic, practically involuntary, action to which so many accidents are due, but also as showing the qualities which should characterize a safeguard. It should effectually prevent or estop these instinctive efforts of the aroused worker which are liable to lead to accident.

An admirable example of this positive kind of a safeguard is found in a device recently perfected for use on stamping presses. It is more fully described on page 67. This device has a swinging rod which, when the die rises, retreats to the rear out of the way. When from any cause the die descends the rod is, by the motion of the machine, swung forward under the die. It gives a sharp warning, in itself enough to cause withdrawal in time to avoid danger. Further than this, the device is strong enough to push the worker's hand away, if not involuntarily withdrawn. Should a scrap of tin become entangled in the die, and the worker essay to pull it out with the fingers, even if at the same moment the machine be released, the ever-ready monitor springs to the front to avert injury.

Such a degree of safety is desirable both to spare the worker and to afford conditions for the most productive operation of the machine.

Many superintendents have commented upon the fact that accidents come in groups. The explanation is perhaps not far to seek. The misfortune of one worker begets a state of nervous attention on the part of those engaged in similar operations and, particularly with the younger workers, a series of accidents is quite likely to happen, not because they become more "careless," but simply from the strain of being unusually careful.

What has been said above is enough to show that for the sake of lessening the nervous strain and for the avoidance of specific accidents no extreme of thoroughness in safeguarding is beyond reason. It is clearly evident that the problem is not one involving an irresponsible agent, the machine, and a responsible one, the worker, but that in many cases the worker is hardly more responsible than the machine. When the spontaneous and necessary activities of a nervous system are brought into relation with the inevitable movements of machines, the possibilities can not be otherwise than serious.

A machine so constructed that at intervals its own parts interfere with each other, causing serious breakage and loss, would be either modified or quickly discarded. Our compound machines of man and metal must be treated in the same way. It is a false assumption that the worker's intelligence and care should be expected to avoid hazards which can be removed by improved construction.

If the worker is regarded strictly as part of the machine rather than as a man, these damaging interferences will soon be greatly lessened.

The discussion shows that a large portion of the accidents usually classed as due to carelessness can not fairly be ascribed to this cause. On the other hand, workers do take risks—unbelievable risks. It is not difficult to understand how this fact has contributed, with others, to produce in the minds of those familiar with working conditions an overestimate of negligence. In the first place, they are unfamiliar with the nervous factors which enter into the problem. In the absence of such knowledge, there are many occurrences which to all appearances are due to negligence. In the second place, these incidents are in the nature of the case spectacular and striking. Common opinion is usually based upon such conspicuous events. They impress the mind, while the ordinary and more numerous cases which should serve as a corrective, only appear when special attention is directed to them. In the course of the investigation this matter was discussed with superintendents and foremen, and without exception they were surprised at the showing made by their own records. When the subject was mentioned, the striking cases naturally came to mind and were offered in evidence. The evidential value of the ordinary cases, which either must be or certainly might be otherwise explained, had not come in for due attention.

Finally, the tendency to emphasize negligence has received a great impulse from the method of dealing with compensation for accident. Facing in every case the uncertainties of a damage suit, the employer is rather forced to make the most of every possible defense. This leads inevitably to exaggerated attention to evidences of neglect.

Accidents themselves are now receiving a needed and reasonable attention. The next step must be to rightly estimate some of the underlying causes which contribute directly to accident occurrence, and are even more important because they undermine the whole structure of physical efficiency. Much more needs to be known of the effect of increased speed of production. How fast may the human machine work and still endure through its rightful period? Until this is more accurately known than now we can not hope reasonably to adjust the burdens of the working day. Until that adjustment is made we can not know whether some distressing social phenomena, such as the abuse of stimulants, for example, are cause or effect.

MACHINERY AS A SOURCE OF DANGER.

It may properly be said that each of the dangers enumerated in the following discussion has been found exemplified in establishments visited during this investigation. Actual cases of nearly every injury mentioned as possible have come under notice either in metal manufacture or in allied industries having identical machines. It has not been necessary to draw upon the extensive literature of the subject to illustrate or to enforce. It seems not out of place thus slightly to emphasize that the material of this presentation is not drawn from a source even in a small degree academic.

The various kinds of machinery from which danger of accident is likely to arise may be conveniently grouped under the following heads:

1. Prime movers.
2. Shafts.
3. Belts.
4. Machine tools.
5. Elevators.

PRIME MOVERS.

In the large establishments the women and children rarely have anything to do with the prime movers. Not more than once or twice during the investigation was a boy under 16 found employed in an engine room, and then only at work which involved little occasion to approach the danger points. While this is the case, it must be said that the fencing of the prime movers was in many cases wholly inadequate, while in a relatively few cases it was entirely wanting.

The common error is the use of a single rail. This can never be adjusted so as to be safe. If high enough to fend off the tall passer-by it is possible for the shorter individual to slip under. The double rail with the frequent use of a skirting board near the floor is the only adequate safeguard.

The serious danger from prime movers comes with the introduction of the small gas or gasoline engine into the smaller shops. These internal-combustion engines are apparently so simple and harmless that makers are as yet taking little thought of safeguarding them, yet not a few have rapidly moving parts which are entirely unguarded and are capable of inflicting serious damage. Apparently, a harvest of injury is necessary to impress the idea of reasonable care upon the makers. An instance of the indifference with which unnecessary dangers are permitted is found in the fact that with the great majority of these engines the starting is accomplished by using the flywheel as a crank. As the engines always start with a jump the danger is evident. It is quite common to intrust the care of such engines to relatively unskilled persons, who not infrequently are boys under 16. To render them reasonably safe the flywheel should be completely fenced, bevel gears and other moving parts should be covered in, and a properly geared starting crank provided.

On the whole, electric generators and motors are constructed in a way to present little danger, though greater care in covering moving parts is desirable. Where motors are used at each machine and are turned on and off by the operator, an extra degree of care in construction is essential and is entirely possible with very trifling added expense. In view of the well-known dangerous character of electricity it seems almost unnecessary to say that when motors are placed on or near the floor where operatives pass from time to time a railing should always be used. Nevertheless, this investigation disclosed several cases of large electric motors standing on the floor, entirely unfenced. In passing one of the exposed motors a test was made with a handkerchief which indicated that the skirts of passing women workers might be affected by the electrical attraction. While the danger is not serious, it should be eliminated.

SHAFTS.

The use of shafts as a means of transmission of power to the point of application was, until the introduction of electrical transmission, almost the exclusive method, and is still nearly universal. Even when electrical motors are in use, they very commonly drive shafts which transmit power to the individual machines.

It is a recognized rule that for the sake of safety overhead shafting should be at least 7 feet from the floor, and it is of equal importance that it should be free from protruding bolt heads or projections of any kind, yet numerous cases were found in which both these provisions were ignored. In many factories machines have been installed in rooms not originally intended for them, which are often very low studded. When in such cases shafting is hung overhead it is frequently too low for safety. Again, a shaft of any considerable length is necessarily made up of several parts fastened together by means of collars. It is still too frequently the case that these junctions, instead of being made fast by hollow set screws, have projecting bolt heads. These may fairly be characterized as the most serious menace connected with shafting. A touch of some loose portion of a garment causes the unfortunate worker to be whirled about the swiftly moving shaft. From the nature of their clothing women are especially exposed to the risk of such disasters.

So frequent and so horrible have been the accidents from this cause that in several States what amounted to a crusade against projecting bolt heads has been undertaken by the bureau of factory inspection, with most commendable results. The unfortunate fact is that when an inspector is congratulating himself upon having rid his district of this threat to the life of the worker new lines of shafting are going up bristling with these deadly projections. Such cases have been observed in the progress of this investigation.

In one State whose laws are admirable and general conditions up to the best standard, several inspectors were apparently unaware of the existence of the hollow set screw and doubtful whether under the law in their State they were entitled to require the use of such a device. Made safe in this particular, the shaft still requires careful guarding, and if anywhere below the prescribed limit of 7 feet it should be securely boxed in. Even when smooth and polished it is a danger. Following is an instance: In a basement room a line of shafting ran closely under the ceiling, less than 6 feet from the floor. Under the direction of the factory inspector the projecting screws had been replaced by a safer device. A young girl, passing from her work, was combing her hair as she went. Under the shaft she gave a little toss. In a flash a few strands were drawn about the shaft, the mass was entangled, and the scalp torn off.

Since approach to the shaft while in motion is sometimes essential, a railed gallery from which operations can be conducted is possible where the shafting is very high. Such a gallery should have a rail at least 3 feet high on the side next the shaft and a skirting board to guard against slipping against the shaft. Measures of necessary severity should be taken to prevent a workman from planting a ladder against a wall and then climbing up between the ladder and a shaft.

Not infrequently the direction of a shaft is changed by means of bevel wheels. These should always be fully inclosed, the case being constructed to open for purposes of cleaning and oiling.

BELTS.

Four sources of danger accompany the use of belts as transmitting devices. First, the lacing of the belt end or some portion of the belt itself may become loosened. This projecting portion, moving at high velocity, may inflict a serious wound on some one standing at an apparently safe distance. Second, a worker may become entangled in an unguarded belt. Third, in slipping a belt upon a moving shaft a serious risk is run. Fourth, a belt unshipped from its pulley and left dangling from the shaft is particularly liable to cause injury.

The first of these dangers calls for most scrupulous care as to the quality of the belt and its accurate adjustment, and for frequent and rigid inspection. Adequate care in inspection would nearly abolish accidents from this source and greatly lessen the chance of the more serious ones which attend the occasional breaking of a belt.

The second danger is easily guarded against. When a belt runs through or near the floor it can be so fenced as to make impossible the entanglement of even the most unwary passer-by.

The third danger may also easily be diminished, if not entirely done away with.

The very general requirement that machines be provided with loose pulleys and a belt fork by which the belt may be shifted without touching the moving parts has done a great deal to remove the danger of belt shifting. In the actuation of stamping presses in metal work such an arrangement is not provided. Whenever a press requires repair the belt is unshipped from the flywheel of the press and, so far as observed, nearly always left dangling from the shaft. The speed of the shaft in this case is not very high, which lessens the risk. Nevertheless, the occurrence of serious accidents under these circumstances shows that it is a risk which should be guarded against.

Few shafts run at a speed which makes the shipping of belts, while the shaft is moving, a safe process. It is constantly done, however. There is less risk when some one of the devices known as belt poles are used. These obviate the use of ladders, but are themselves a source of no little danger, since the pole becoming entangled in the belt may deal a severe, even fatal, blow. Inventive genius should provide some better device for this purpose than anything now in use.

The prompt stopping of mill gearing in case of accident is of the highest importance. Cases have been noted where the only way that the shafting of a large mill could be brought to a standstill in any part was to send a messenger to the engine room. Too often before the ponderous fly wheel would come to rest the fatal mischief would be done, which might have been avoided had some readier means been available for stoppage. Quick communication with the engine room by telephone or speaking tube or other signal does not solve the problem. The vast momentum of the great engine can not possibly be overcome in a moment. Existing devices by which a portion of the machinery can be quickly controlled should be generously supplied. This has its utilitarian as well as humanitarian side since, as at present installed, accident to work people, or need of repair, means in some cases the stoppage of the entire mill.

MACHINE TOOLS.

Reference to the table on page 81 will show the variety of machines in use in the metal trades which were found to have caused injury by accident. The stamping press is far in the lead among these machines, a fact of special importance in view of the very general employment of women to operate it. The essential parts of the stamping press are these: First, there is a strong iron frame carrying a heavy fly wheel; second, upon the axis of this wheel there is an eccentric; third, actuated by the eccentric, a frame is moved up and down in guides which are carefully made to insure steady and exact movement; fourth, this frame carries a steel die, which may be changed to suit the exigencies of the work; fifth, there is a table, sometimes horizontal, but oftener inclined, on which is placed the complement of the die and to which the die descends at the lowest point of its excursion. The movement is so adjusted that at its lowest point very great power is exerted. The movement is sufficiently rapid to make the action of the die essentially a blow rather than pressure.

An important accessory of the machine is the trip rod, actuated by a treadle. When the piece of metal has been put in place upon the bedplate, the operator presses the treadle, the mechanism is released, the die descends, and the metal is cut, pressed, or drawn, as the case may be. The description at once makes evident the nature of the worker's danger. He must put the metal in position to receive the blow of the die, but if for any cause his fingers are not removed in time, or are introduced at an improper moment, they receive the force of a blow sufficient to mold cold metal into desired forms. The injury varies from the cutting off of the pad of flesh at the finger tip to the crushing of the entire hand, or, in a few rare instances, both hands.

Various devices have in recent years been applied to render these presses less dangerous. The figures given in the section on accidents (pp. 74, 75) show a striking decrease in accidents where such devices have been adopted. It is scarcely surprising that, to one personally familiar with the old conditions, the present situation seems so good as scarcely to demand further improvement.

The devices most generally used have one serious fault; it is possible for the operator to put his fingers over, under, or through the guard which is supposed to keep them out of danger. The exigencies of the work are sure to afford occasions for those instinctive actions already described, resulting in accident of greater or less seriousness.

A much better and very generally applicable form has as its essential parts: First, a vertical revolving shaft; second, adjustably attached to the shaft a horizontal rod; third, projecting from the moving parts of the machine an arm carrying at its extremity a sleeve through which the vertical shaft passes. On the interior surface of this sleeve is a lug which engages in a spiral groove cut into the shaft. It is evident that the action of the press will impart rotation to the shaft. The horizontal rod is so fastened that, when the die rises, it swings back out of the way. Upon the descent of the die, the rod comes forward, clearing the die just before the blow is delivered. If fingers are, for any cause, at the danger point, the swinging rod effectually removes them. In many cases, the backward swing of the rod will remove the completed piece, thus helping the output of the machine.

The great advantage of such a safeguard is the positive nature of its action. Its warning is delivered at the appropriate instant and can be neither avoided nor disregarded. Not even those unconscious and unintentional excursions into danger which we have discussed before can escape its vigilance.

Another device of importance must be mentioned in this connection. In the majority of presses as now constructed, if the treadle be depressed, the machine continues its excursions until the foot is removed. Anything disturbing the rhythm of the operator's work may result in holding down the treadle and the continued action will result in accident. The device referred to is an arrangement of the tripping rod such that upon pressing down the treadle the machine makes but a single excursion. The treadle must be released and actuated again to cause a second movement.

ELEVATORS AND HOISTS.

These require but brief consideration, since the number of boys employed in operating is inconsiderable and the occurrence of some particularly serious accidents has hastened the movement toward putting these machines entirely in the hands of older workers. The chief sources of danger are: First, an uncovered cage into which objects falling down the shaft have unrestricted access; injury and death from this cause have been not infrequent. Second, imperfectly guarded openings into the shaft permitting the employee to fall into the same. Third, worn cables used in hoisting or operating the elevator or hoist.

The first danger is easily met in many cases by requiring that the cage shall be provided with a substantial roof. For the second, automatic doors, which open and close at the coming and going of the cage, are probably best. These are of several different patterns, each with its own advantages. The chief fault with those which open at the side of the cage is lack of sufficient height. Repeated instances were noted where the work people leaned over a low gate and were sharply reminded of their folly by a blow from some falling object. Such an occurrence might easily take on the character of a serious accident.

For faulty cables, there seems no help but the most exacting vigilance in inspection. With the plunger type of elevator, this danger is nearly or quite absent, except that the ropes carrying the counterweights may break and, if the weights are not secured in some way, they may fall upon the car and do harm.

The concrete evidence will now be offered that these sources from which injury might be expected are really of some serious importance.

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CHAPTER V.

ACCIDENTS IN THE METAL TRADES.

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ACCIDENTS IN THE METAL TRADES.

An analysis of a group of the accidents occurring within the range of this investigation and a comparison of their number with the size of the industrial army in which they occurred may be of assistance in attaining a clear understanding of the situation.

ACCIDENT RATES IN DIFFERENT TRADES.

The custom in regard to keeping records of accidents varies considerably from place to place and even from factory to factory. In some establishments only the briefest and most formal records of accidents were kept, while in others details were preserved with varying degrees of completeness. In many of the factories reports were so scanty that it was impossible to use them as a basis for general conclusions. For a group of 60 establishments, however, employing 48 per cent of the total number of workers given in the table on page 12, information was obtained showing the relative danger of the different trades to adult workers and to children. The table below shows for each trade the number of employees and the accident rate for adults and by sex for children.

NUMBER OF ADULTS AND OF MALE AND FEMALE CHILDREN EMPLOYED IN 60 ESTABLISHMENTS, AND ACCIDENT RATE FOR EACH GROUP, BY INDUSTRIES, 1907.

Industry.	Number of establishments.	Employees.						
		Total 16 years and over.		Males under 16 years.		Females under 16 years.		Total employees
		Number.	Number injured per 100 employed.	Number.	Number injured per 100 employed.	Number.	Number injured per 100 employed.	
Bolts and screws	1	1,351	0.59	21	....	19	....	1,391
Bottle caps	3	510	6.86	10	....	6	....	526
Brass ware	7	8,595	7.68	55	10.91	22	....	8,672
Enameled ware	1	722	2.77	11	....	4	....	737
Firearms and ammunition	1	5,317	3.50	....	....	....	....	5,317
Hardware	6	9,528	9.50	87	....	43	....	9,658
Lanterns	1	274	7.30	....	....	....	....	274
Metal novelties	3	303	6.60	7	....	6	....	316
Metal specialties	3	1,618	1.48	15	....	14	....	1,647
Telephones	1	6,000	.92	....	....	....	....	6,000
Tin cans	12	3,670	10.82	56	....	22	....	3,748
Tinware	5	1,000	7.00	14	....	4	....	1,018
Paper boxes	16	1,323	4.16	23	....	69	10.14	1,415
Total	60	40,211	6.11	299	2.01	209	3.35	40,719

Considering first the children, it will be seen that in these selected establishments they form a very small proportion (1.25 per cent) of the whole number of employees, and that their accident rate is much smaller than that prevailing among the adults. This seems due entirely to a general tendency not to allow these younger employees to work on dangerous machines. In the very few cases in which this precaution was not observed, their accident rate rose to striking figures. Thus, all the accidents to boys under 16 in the brass shops studied occurred in one factory, the only one in which they were to any extent employed on stamping presses, punch presses, and the like. In that particular factory their accident rate was 16.7 per cent.

Turning from the children to the adults, the accident rates given indicate very fairly the relative hazards of the different industries. It will be noticed that the manufacture of tin cans shows the highest rate, followed closely by hardware, and then by brass ware and tinware. Some of the other industries show high rates, but for the most part they employ too few workers to justify any conclusion as to their real hazards.

One difficulty in the way of determining the dangers of an industry lies in the wide variations in the accident rates of factories or workshops manufacturing similar products. One of the brass shops listed above, for instance, in which 203 women were employed, showed an accident rate among the female employees of 26.6 per cent, while a second, employing 129 women, showed an accident rate of 11.63 per cent among them. Both of these were in most respects admirable factories, but in the second scrupulous care had been exercised in choosing machinery of the least hazardous type obtainable, and many additional safeguards had been devised and applied. These factories present a contrast between good and better conditions, and serve to show rather clearly the value of alert and attentive effort to prevent even minor accidents.

A good illustration of the difference in safety caused by attention to even a single detail was found in the tin-can industry. The two factories compared used nearly the same number of presses and produced almost an identical line of goods, but in one a safety device not found in the other was in use. In the first factory 150 women were employed, 13.33 per cent of whom suffered accident during the year considered. In the second, in which the safeguard was in use, of the 187 women employed, only 3.21 per cent had been injured.

But the most striking contrast was found between two firms engaged in the manufacture of hardware and producing essentially the same class of goods. One firm occupied a rather old building, in which, owing to the low studding of some of the stories, shafting ran much too near the workers. In such matters as projections upon revolving parts, unprotected belts, and stamping presses operated without safeguards, the records of inspection showed many things capable of improvement. This establishment, employing 1,006 men, had among them an accident rate of 17.49 per cent, while among the 138 women employed the rate was almost identical—17.39 per cent. The other establishment had, on the whole, better buildings, and much more care had been taken in guarding against the dangers suggested above. Here, among its 2,488 male employees the accident rate was 3.22 per cent, while among its 500 women the rate sank to 1.40 per cent.

It is not claimed that in any of these cases the smaller accident rate was wholly due to the greater use of safeguards, but it is evident that this forms at least an important factor in the situation.

ACCIDENT RATES FOR MEN AND WOMEN.

The following table, permitting a comparison between factories, gives some indication of the relative hazard to men and women. It covers but 16 establishments, but these are among the largest visited and employ in the aggregate 16,070 males 16 years and over, 4,729 females 16 years and over, 188 males under 16, and 82 females under 16, the grand total being 21,069.

EMPLOYEES, ACCIDENTS, AND ACCIDENT RATES IN 16 ESTABLISHMENTS, BY SEX AND AGE GROUPS.

Establishment.	Employees 16 years and over.						Employees under 16 years.						Total employees.	
	Male.		Female.		Total.		Male.		Female.		Total.			
	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.
Bolts and screws:														
1	853	5	498	3	1,351	8	21	......	19	......	40	......	1,391	8
Brass ware:														
1	663	158	203	54	866	212	......	......	......	......	......	......	866	212
2	266	52	129	15	395	67	1	......	4	......	5	......	400	67
3	800	138	250	11	1,050	149	36	6	9	......	45	6	1,095	155
Total	1,729	348	582	80	2,311	428	37	6	13	......	50	6	2,361	434
Enameled ware:														
1	657	18	65	2	722	20	11	......	4	......	15	......	737	20
Firearms and ammunition:														
1	3,974	132	1,343	54	5,317	186	......	......	......	......	......	......	5,317	186
Hardware:														
1	1,006	176	138	24	1,144	200	20	......	1	......	21	......	1,165	200
2	2,091	223	437	14	2,528	237	29	......	34	......	63	......	2,591	237
3	594	100	394	100	988	200	6	......	6	......	12	......	1,000	200
4	1,100	99	198	11	1,298	110	15	......	2	......	17	......	1,315	110
5	2,488	80	500	7	2,988	87	12	......	......	......	12	......	3,000	87
6	445	63	137	8	582	71	5	......	......	......	5	......	587	71
Total	7,724	741	1,804	164	9,528	905	87	......	43	......	130	......	9,658	905

EMPLOYEES, ACCIDENTS, AND ACCIDENT RATES IN 16 ESTABLISHMENTS, BY SEX AND AGE GROUPS—Concluded.

Establishment.	Employees 16 years and over.						Employees under 16 years.						Total employees.	
	Male.		Female.		Total.		Male.		Female.		Total.			
	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.	Number of employees.	Number of accidents.
Tin cans:														
1..........	220	38	40	6	260	44	6	......	......	......	6	......	266	49
2..........	73	18	60	14	133	32	1	......	3	......	4	......	137	32
3..........	250	94	150	20	400	114	......	......	......	......	......	......	400	114
4..........	590	44	187	6	777	50	25	......	......	......	25	......	802	50
Total....	1,133	194	437	46	1,570	240	32	......	3	......	35	......	1,605	245
Grand total..	16,070	1,438	4,729	349	20,799	1,787	188	6	82	......	270	6	21,069	1,798

Establishment.	Employees 16 years and over.						Employees under 16 years.					
	Male.		Female.		Total.		Male.		Female.		Total.	
	Per cent of total employees.	Accidents per 100 employees.	Per cent of total employees.	Accidents per 100 employees.	Per cent of total employees.	Accidents per 100 employees.	Per cent of total employees.	Accidents per 100 employees.	Per cent of total employees.	Accidents per 100 employees.	Per cent of total employees.	Accidents per 100 employees.
Bolts and screws:												
1..........	61.32	0.59	35.80	0.60	97.12	0.59	1.51	......	1.37	......	2.88	......
Brass ware:												
1..........	76.55	23.83	23.45	26.60	100.00	24.48	......	......	......	......	......	......
2..........	66.50	19.55	32.25	11.63	98.75	16.96	.25	......	1.00	......	1.25	......
3..........	73.06	17.25	22.83	4.40	95.89	14.19	3.29	16.67	.82	......	4.11	13.33
Total....	73.23	20.13	24.65	13.75	97.88	18.52	1.57	16.22	.55	......	2.12	12.00
Enameled ware:												
1..........	89.15	2.74	8.82	3.08	97.97	2.77	1.49	......	.54	......	2.03	......
Firearms and ammunition:												
1..........	74.74	3.32	25.26	4.02	100.00	3.50	......	......	......	......	......	......
Hardware:												
1..........	86.35	17.49	11.84	17.39	98.19	17.48	1.72	......	.09	......	1.81	......
2..........	80.70	10.66	16.87	3.20	97.57	9.38	1.12	......	1.31	......	2.43	......
3..........	59.40	16.83	39.40	25.38	98.80	20.24	.60	......	.60	......	1.20	......
4..........	83.65	9.00	15.06	5.56	98.71	8.47	1.14	......	.15	......	1.29	......
5..........	82.93	3.22	16.67	1.40	99.60	2.91	.40	......	......	......	.40	......
6..........	75.81	14.16	23.34	5.84	99.15	12.20	.85	......	......	......	.85	......
Total....	79.98	9.59	18.68	9.09	98.66	9.49	.90	......	.44	......	1.34	......
Tin cans:												
1..........	82.71	17.27	15.04	15.00	97.75	16.92	2.25	......	......	......	2.25	......
2..........	52.28	24.66	43.80	23.33	97.08	24.06	.73	......	2.19	......	2.92	......
3..........	62.50	37.60	37.50	13.33	100.00	28.50	......	......	......	......	......	......
4..........	73.56	7.46	23.32	3.21	96.88	6.44	3.12	......	......	......	3.12	......
Total....	70.59	17.12	27.23	10.53	97.82	15.29	1.99	......	.19	......	2.18	......
Grand total..	76.27	8.94	22.45	7.38	98.72	8.59	.89	3.19	.39	......	1.28	2.22

It is noticeable that in these establishments the accident rate is very generally smaller for women than for men. In only five cases does the rate for women show an excess, and in only one of these—the hardware establishment numbered three—is the difference large enough to be important. The striking variations within a single industry—the accident rate for women in the six hardware establishments, for instance, ranging from 1.40 to 25.38, and in the three brass-ware factories from 4.40 to 26.60—show the impossibility of reaching any safe conclusions as to the necessary hazards of these industries from the data at present obtainable. The most that can be said for the above table is that it shows clearly that in these leading establishments children formed but a very small percentage of the total employees and had a much smaller accident rate than the adults; that women formed approximately a little over one-fifth of the total number of employees, their proportion varying in different establishments from 8.82 per cent to 43.80 per cent; that their accident rate was, on the whole, smaller than that of the men; and that where the women's rate was higher the difference was usually trivial. When the occupations in which each sex is engaged are considered it becomes at once evident that the males are found in those of greater hazard. The extent to which this is true is not fully reflected in their higher accident rates. A study of the separate establishments showed that whenever a high accident rate for women appeared it was associated with their employment in large numbers upon stamping presses.

DETAILS AS TO NATURE AND CAUSE OF ACCIDENTS.

For the purpose of learning something about the nature and cause of accidents, especially to women and children, special records were made of cases for which comparatively full data could be obtained. As mentioned before, there was much difficulty in securing such data, but fairly full details were secured for a group of 571 accidents occurring during the year 1907 in 69 establishments.[a] These establishments were distributed among the industries, as shown in the following table:

NUMBER OF ACCIDENTS AND NUMBER OF ESTABLISHMENTS IN WHICH THEY OCCURRED, BY INDUSTRIES.

Industry.	Number of establishments.	Number of accidents.
Bolts, screws, etc	1	3
Bottle caps and tinfoil	3	17
Brass ware	7	116
Corset steels	1	2
Enameled ware	1	2
Hardware	7	150
Lanterns	1	3
Metal novelties	3	7
Metal specialties	2	5
Silverware	1	4
Telephones	1	23
Tin cans	13	145
Tinware	3	4
Paper boxes	16	63
Miscellaneous	9	27
Total	69	571

[a] These figures do not represent all the accidents occurring during the year in the given establishments, but only those for which certain details were secured.

So various are the interpretations given to the expression "serious injury" that, for this discussion, it has been arbitrarily defined as any injury involving permanent bodily mutilation or deformity, or entailing loss of time to the extent of two weeks or more. Classed according to this definition the 571 accidents under consideration show 170 persons seriously injured and 401 persons slightly injured.

Comparing these figures with available data from other industries, it appears that this proportion of injuries, which may fairly be classed as serious, is high, very much higher than in most industries in which women and children are engaged. The incompleteness, however, of this list of 571 accidents makes it doubtful whether this conclusion could be sustained. On the one hand, little effort was made in compiling it to secure returns concerning men, and as men are usually employed in the occupations of greatest hazard, a complete list of the accidents befalling them would probably have increased the proportion of cases in which serious injury was received. On the other hand, the list is limited to the accidents for which relatively full information could be obtained. Naturally, the more serious accidents would be more carefully recorded and more fully remembered than the trivial, so that this cause would tend to overweight the figures showing serious injuries. All that can safely be said is that serious injuries were neither rare nor confined to adult males.

The following table shows for the 571 accidents the number involving each specified kind of injury:

NUMBER OF ACCIDENTS INVOLVING EACH SPECIFIED KIND OF INJURY.

Nature of injury.	Number of accidents.	Nature of injury.	Number of accidents.
Fingers wholly or partially cut off	35	Injured by fall	1
Fingers crushed	129	Burns with acid	1
Fingers bruised or lacerated	166	Burns with hot metal	1
Fingers or hands cut	155	Concussion of brain	1
Finger nails pulled off	38	Hand lacerated on buff wheel	1
Cuts on head	6	Nervous shock	1
Cuts on arm	5	Leg broken	1
Arm bruised	5	Electric shock	2
Poisoning following puncture or scratches	6	Unclassified	11
Eye cut or punctured	5		
Back strained	1	Total	571

It will be observed that by far the larger part of these accidents are accidents of various degrees of severity to the hands. A later table, showing the machines responsible, will indicate why this is the case. Aside from this group, the accidents are of the sort which may occur in any factory. The manipulation of brass involves, more than is the case with the other metals, the liability to infection and serious results. This is sometimes attributed to some poisonous property of the metal itself. This is probably not the case, but the liability requires that in brass shops even apparently trivial abrasions should be thoroughly cleaned and protected from the intrusion of germs.

The physical results of these accidents may be seen from an examination of the following table:

PHYSICAL RESULTS OF THE ACCIDENTS.

Physical results of the accidents.	Number of accidents.	Physical results of the accidents.	Number of accidents.
Entire loss of one or more fingers	22	No permanent results	402
Loss of one or more joints of finger	61	Unknown	5
Deformity of hands or fingers	78		
Hand rendered entirely useless	2	Total	571
Loss of eye	1		

On the face of the records, the number who suffered some permanent physical disability was 28 per cent. This is larger than occurs in many other lines of manufacture. Moreover, this does not tell the whole story, because in the above table all cases in which merely the fleshy tip of the finger was nipped off have been classed as having no permanent result. Such accidents usually leave no more serious visible results than a scar, but a careful inquiry among the operatives seems to indicate that a real loss of dexterity is entailed. The sensibility of the part is more or less destroyed and to some degree manipulation is not so sure and ready. Had such cases been included the percentage of those suffering permanent physical disability would have been much larger.

The direct cause of accidents, so far as ascertainable from the records, is shown in the first table following. A second table gives the underlying cause.

DIRECT CAUSE OF ACCIDENT.

Direct cause of accident.	Number of accidents.	Direct cause of accident.	Number of accidents.
Ordinary use of machine	439	Caught on shaft	1
Operating contrary to orders	66	Caught in swinging door	1
Carelessness of fellow worker	8	Contact with poisonous substances	1
Slipped on floor	7	Fell from ladder	1
Struck by flying splinters	3	Handling tools	1
Cut by wire	3	Lifting weight	1
Stepped on nail	3	Unclassed	33
Punctures by metal	2		
Burned with acid	1	Total	571

UNDERLYING CAUSE OF ACCIDENT.

Underlying cause of accident.	Number of accidents.	Underlying cause of accident.	Number of accidents.
Careless manipulation	174	Imperfect mechanism	26
Taking of risks	56	Unclassed	234
Inattention to surroundings	6		
Unforeseen liability	75	Total	571

The common complaint of superintendents and foremen is that operatives are deliberately careless or, if not deliberately so, that they become inattentive and automatic as they become familiar with their work. Some even go so far as to object to safeguards on the ground that they promote this spirit of carelessness.

The large group of unclassed in the last table indicates the difficulty which besets any effort to appraise these factors. In this group the evidence as to the responsibility for the accident is either insufficient or entirely lacking. It must be noticed that the personal equation intrudes constantly. A foreman whose duty it is to see that machines are in proper order would be scarcely human did he not instinctively tend to attribute much to careless operation. The operative, on the other hand, is even more sure to accuse the machine. In the operation of stamping presses, it is almost the rule for the worker to say "the press repeated." In one factory a foreign girl who could speak but little English crushed the first joint of her finger. On coming to the emergency room for treatment, she at once began to say "repeated," "repeated." Inquiry developed that she was undertaking to explain the accident. Further inquiry brought out the fact that she operated a foot press. She had learned the formula. With such conflicts of interest and statement, it is exceedingly difficult for disinterested investigators to be sure that these colorings have been properly excluded and the real facts ascertained.

The records are made from the standpoint of the foreman rather than the injured, and so we may be fairly sure that they do not err in the direction of attributing too little to the factor of carelessness. Furthermore, it is distinctly the foreman's duty to his employer to set down in these records any known evidence of neglect on the part of the worker. The foreman represents the management. The records are for insurance companies and are looked to for suggestions regarding proper defenses in case of suits arising. This makes it inevitable that he will be alert to notice and careful to insert anything appearing to show negligence. He can not be expected to present with equal care defects in operative condition which may be due to his own neglect. Agreeing that as much is attributed to the operator's lack of care as the facts will warrant, the indications certainly are that this is not the main factor in the situation. The classification of the underlying causes above given shows that in only 236, or 41.3 per cent, of the 571 cases was satisfactory evidence found that the operative was in any degree responsible for the accident. Even in the 41.3 per cent in which the worker was found to be in some degree responsible, it is difficult to say how far he was really accountable. The effect of imperfect light, undue speed, lassitude from impure air, all come in, in degrees absolutely impossible to estimate with any sort of exactness. Until every possible precaution to remove these causes of accident has been taken by employers, very strong emphasis upon operative carelessness is not justified. It is proper here again to repeat what has already been said under the discussion of machine dangers. For the most satisfactory production a degree of safety is necessary which permits the worker to operate without strain in a sort of automatic fashion sometimes wrongly termed carelessness. A constant strained attention to avoid danger must finally react unfavorably both upon the worker and his work.

The following table shows the distribution by sex and age of those injured in these accidents:

SEX AND AGE OF WORKERS SUFFERING ACCIDENT.

Age group.	Males.	Females.
Under 16 years	21	7
16 to 20 years	43	270
21 to 30 years	14	110
31 to 40 years	3	8
41 to 50 years	3	1
Age unknown	46	45
Total	130	441

The preponderance of females in the showing is owing to the fact that in many of the largest establishments the records for women and children only were taken. The purpose of the compilation was primarily to show to what kind of danger and to what extent these employees were exposed. Such showing as is made regarding adult males is purely incidental.

Since the age distribution of the employees of these establishments is not available no definite conclusions can be drawn from these figures. In single factories in which the age grouping of the employees could be obtained, it was found that the number of accidents to women in the age group 16 to 20 was disproportionately large, but the basis of comparison was not sufficient for positive conclusions.

Of special importance to an understanding of the causes of accident in these industries is a knowledge of the machines to which the accidents are due. The number of accidents due to each machine is shown in the following table:

MACHINES CAUSING THE ACCIDENTS.

Machines causing accident.	Number of accidents.	Machines causing accident.	Number of accidents.
Power stamping presses	231	Gears	1
Foot presses	60	Header press	1
Riveter	22	Lathe	1
Power presses with feeding devices	20	Metal saws	1
Drill presses	8	Reamer	1
Former in can shops	7	Shafts	1
Seamer in can shops	5	Swedger	1
Punch presses	5	Staying machines in box shops	52
Roll threaders	4	Ending machines in box shops	2
Belts	3	Corner cutter machines in box shops	1
Trimmer	3	Paper cutter machines in box shops	1
Spinner (metal)	2	Wrapping machines	1
Bale bender	1	Other machine and nonmachine accidents	131
Buff wheel	1		
Bumping press in cam shops	2		
Drop hammer	1	Total	571
Groover	1		

A single glance at the foregoing will indicate the reason why so many of the accidents are to the hands. Presses of various kinds are responsible for over half of these cases of injury, and, as the description already given of these machines clearly shows, their chief danger is to the hands of the operator.

Next to the presses the staying machine used in box shops is responsible for the largest number of these accidents. The makers of these machines have provided safeguards for them, but many box manufacturers will not use these, saying, apparently in good faith, that they are useless or even harmful. Others say that the operatives positively refuse to use them. To test these statements the records of 14 shops in which the guards had been in use were compared with those of an equal number in which they had not been in use.

The 14 shops where the guards were in use operated 46 machines and had 11 accidents. The 14 shops where the guards were not in use operated 48 machines and had 37 accidents. There was nothing in the character or age of the operatives or the nature of the work done to account for this difference.

In this particular case the conclusion is rather forced that the device is rejected, to the danger of the operator, not because it is useless but because it is thought by both manufacturer and worker that its use somewhat lessens output. As the workers are paid by the piece this is an important item to them. Nearly all box shops have a rush season. Between the earners' desire to increase the returns and the employers' desire to raise the output, safeguards are rejected and a notable number of accidents is the result.

ACCIDENTS TO PRESS HANDS.

It has already been shown in the table on page 81 that the different forms of presses, and especially the stamping presses, are responsible for a considerable proportion of the accidents occurring to metal workers. As women are largely employed upon these machines it seemed worth while to make a special study of accidents befalling press hands. For this purpose the records of such accidents were taken for 18 establishments. These records varied widely, both in the fullness with which details were given and in the period covered. For the sake of uniformity, when the records covered two or more years, they were reduced to a one-year basis by multiplying the number of employees by the number of years covered. This was done on the assumption that 100 people working under given conditions for two years suffer the same exposure to accident as would 200 working under the same conditions for one year. The following tables relating to press hands are therefore based on an exposure of one year.

The accident rates for male and female press hands are shown by establishments in the following table:

NUMBER OF PRESS HANDS EMPLOYED, TOTAL NUMBER INJURED BY ACCIDENT, AND NUMBER INJURED PER 100 EMPLOYED, BY SEX, FOR EACH ESTABLISHMENT.

Establishment number.	Years recorded.	Number of press hands.			Number exposed for 1 year.			Number injured.			Number injured per 100 employed for 1 year.		
		Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.
1	5	26	82	108	130	410	540	110	406	516	84.61	99.02	95.56
2	2	15	3	18	30	6	36	26	4	30	86.67	66.67	83.33
3	5	40	20	60	200	100	300	66	28	94	33.00	28.00	31.33
4	4	40	35	75	160	140	300	153	109	262	95.63	77.86	87.33
5	6	40	12	52	240	72	312	107	29	136	44.58	40.28	43.59
6	3	51	18	69	153	54	207	151	85	236	98.69	157.41	114.01
7	2⅔	17	53	70	46	141	187	15	138	153	32.61	97.87	81.82
8	4⅓	35	78	113	152	338	490	15	89	104	9.87	26.33	21.22
9	4	25	34	59	100	136	236	13	22	35	13.00	16.88	14.83
10	5	28	32	60	140	160	300	60	85	145	42.86	53.13	48.33
11	2	31	50	81	62	100	162	6	47	53	9.68	47.00	32.72
12	2	50	15	65	100	30	130	23	7	30	23.00	23.33	23.08
13	2	33	24	57	66	48	114	12	7	19	18.18	14.58	16.67
14	2	40	26	66	80	52	132	18	12	30	22.50	23.08	22.73
15	2	13	12	25	26	24	50	5	9	14	19.23	37.50	28.00
16	6	32	20	52	192	120	312	31	16	47	16.15	13.33	15.06
17	2	34	20	54	68	40	108	1	6	7	1.47	15.00	6.48
18	3	45	14	59	135	42	177	47	7	54	34.81	16.67	30.51
Total.		595	548	1,143	2,080	2,013	4,093	859	1,106	1,965	41.30	54.94	48.01

The most immediately striking feature of this table is the variation in the accident rate from factory to factory. This variation is so wide as to seem at first sight almost incredible, yet it reflects with considerable accuracy the varying conditions in the pressrooms studied. Few of these establishments operated machines without some form of guard, but the guards used differed greatly in efficiency. The character of the working force varied, and the customs in regard to recording minor accidents were not uniform.

Of all these conditions, perhaps the last mentioned has the most effect in causing variations in the accident rate. It is usually said that the reports furnished by employers to insurance companies "contain every accident, however trivial," and that consequently these reports give a basis for a complete study. This assertion, however, as applied to most establishments is far from the fact. There are a great number of minor accidents with which a workman never bothers his foreman. They are annoying, but not serious, and he says nothing about them. When, however, the employer provides an accessible emergency room, with a nurse in attendance, the workers, if encouraged to use the room, soon learn that the skillful care there afforded has a real value. A compact and well-fastened bandage interferes less with work than a hastily fastened strip from a coat lining, and the after soreness, which even when not incapacitating the worker may seriously hinder him, may be lessened or entirely prevented by proper care. As a consequence the cases recorded in such a room will naturally be much in excess of those which under different conditions would be brought to the foreman's attention and reported to an insurance company. The one case in the above table in which the accident rate runs up to over 100 per cent is an establishment in which such a room is maintained and in which, consequently, accidents are recorded with a degree of thoroughness found nowhere else.

This table shows very clearly the danger involved in operating stamping presses. The accident rates shown are not only impressively high in themselves, but become even more so by comparison with those among the whole group of workers in industries in which these machines are found. They are largely used in the manufacture of brass ware and hardware. A glance at the table on page 76 shows that the general accident rate for these industries stood as follows:

ACCIDENT RATES AMONG EMPLOYEES IN BRASS-WARE AND HARDWARE ESTABLISHMENTS, BY SEX.

	Accidents per 100 employees.		
	Male.	Female.	Total.
Brass ware	20.13	13.75	18.52
Hardware	9.59	9.09	9.49

The wide difference between these figures and those for the press hands alone needs no comment. The same fact is brought out even more forcibly by a comparison between the accident rate for the press hands and the other employees in the same factories. For the 18 establishments studied the rates stood thus:

ACCIDENT RATES AMONG PRESS HANDS AND OTHER OPERATIVES, BY SEX.

	Accidents per 100 employees.		
	Male.	Female.	Total.
Press hands	41.30	54.94	48.01
Other operatives	14.19	5.38	11.75

In considering the degree of hazard indicated by these figures, it must be borne in mind that they are taken from factories in which an effort has been made to reduce the danger by the use of safeguards. In far too many establishments machines are in use with no guards whatever, and, had it been possible to include these in the study, the rates shown in the table would have been changed for the worse to a degree scarcely to be imagined. But the absence of safeguards is usually accompanied by an absence or lack of fullness of accident records, so such establishments had to be omitted.

Even in those factories in which safeguards were employed, the situation, though improved, was by no means what it might be, as the methods in general use for safeguarding these machines are not the best available. A striking example of what might be done was furnished by one concern, which had set itself intelligently and vigorously to the solution of the problem. An immediate result was the discovery of nearly 50 changes which could be made in the machines, tending to greater safety, and also in a number of cases enhancing their productivity. As this concern employed men only, it was not included with the 18 establishments studied, but unquestionably the same methods would produce similar results wherever stamping presses are used.

The table presents a comparison between the relative hazards of men and women, which is of special interest because ordinarily, even when working side by side, the two sexes are engaged in different occupations involving different degrees of danger, so that their accident rates can not fairly be compared. In the press hands, however, we have a group of men and women working in the same occupation and subjected to the same dangers. Conditions are not in every case identical for the two sexes, for stamping presses are not all alike and the more dangerous ones are operated sometimes by women, sometimes by men. The situation represented by the table is, however, equalized between the sexes by the varying practice of different shops, both in regard to the relative number of men and women employed and the sort of machines they operate, so that their accident rates reflect their relative hazards.

Comparing then the accident rates shown in this table for the two sexes, it appears that under practically identical conditions the rate for women is higher in 11 of the 18 establishments studied; that the excess in their rate appears alike in factories where they are relatively few and relatively numerous; that in some cases—as, for instance, in the establishments numbered 6, 8, 11, 15, and 17—this excess is enormous; and that for the whole group the accident liability of the women exceeds that of the men by almost one-third (33 per cent). The evidence seems reasonably conclusive that among press hands at least women run a much greater risk of injury than men.

Another question presents itself, however. Do the women in general meet with as serious accidents as the men, or is their rate brought up by a possible tendency on their part to report trivial injuries which a man would pass over in silence? In a former table injuries were classed at severe if they involved permanent mutilation or deformity, or necessitated an absence of two weeks or more from work. In the 18 establishments studied it was not possible to secure the information necessary for the application of this test, but some light is thrown on the question by the following table, showing the nature of the injuries sustained by this group of press hands:

TOTAL NUMBER OF PRESS HANDS INJURED BY ACCIDENT AND NUMBER INJURED PER 100 EMPLOYED, BY SEX AND NATURE OF INJURY.

Nature of injury.	Male.		Female.		Total.	
	Number injured.	Number injured per 100 employed.	Number injured.	Number injured per 100 employed.	Number injured.	Number injured per 100 employed.
Finger or fingers lost wholly or in part	167	8.03	172	8.54	339	8.28
Finger or fingers crushed or broken	130	6.25	167	8.30	297	7.26
Finger or fingers bruised or lacerated	264	12.74	470	23.35	734	17.93
Cuts on hands or fingers	185	8.84	203	10.08	388	9.48
Cuts not on hands	35	1.68	18	.89	53	1.30
Bruises and lacerations not on hands	20	.96	17	.84	37	.91
Punctured wounds	37	1.78	22	1.10	59	1.44
Infection	7	.34	18	.89	25	.61
Eye injured	6	.29	6	.30	12	.29
Dislocations, etc	5	.24	7	.35	12	.29
Broken limbs	....	....	3	.15	3	.07
Burns and scalds	3	.14	3	.15	6	.15
Total	859	41.30	1,106	54.94	1,965	48.01

The injuries classed under the first two heads must almost inevitably have been serious, but in regard to the others, with the exception of the three cases of broken bones, it is impossible to say whether or not they were severe. The table makes it clear that the excess of the women's accident rate is not due solely to casualties in which the injury received may have been slight, but that it appears very generally throughout the various classes of accidents. It will be observed that there are only three kinds of injuries, none of them numerically important, for which the men's rate is higher.

Turning to the direct causes of these accidents, we have the following table:

DIRECT CAUSE OF ACCIDENTS TO PRESS HANDS, BY SEX.

Direct cause of accident.	Males.		Females.		Total.	
	Number of accidents.	Per cent of total accidents.	Number of accidents.	Per cent of total accidents.	Number of accidents.	Per cent of total accidents.
Ordinary use of machines	610	71.01	846	76.48	1,456	74.09
Disregard of orders	86	10.01	116	10.49	202	10.28
Fellow worker	7	.81	2	.18	9	.46
Falls	13	1.51	6	.54	19	.97
Flying and falling objects	24	2.80	12	1.09	36	1.83
Projecting nails, etc	9	1.05	4	.36	13	.66
Handling material	65	7.57	90	8.14	155	7.89
Belts, shafts, and gears	5	.58	4	.36	9	.46
Use of tools	7	.81	1	.10	8	.41
Lifting weights	1	.12	2	.18	3	.15
Hot metal	1	.12	....	....	1	.05
Unclassified	31	3.61	23	2.08	54	2.75
Total	859	100.00	1,106	100.00	1,965	100.00

It is evident that among these workers the machine is the principal source of danger, the incidental risks to which all factory workers are exposed accounting for only a small proportion of the accidents. The men, as might be expected, show a slightly larger proportion of injuries due to the use of tools, or the manipulation of belts, gearing, etc. It is not exactly clear why they should suffer so much more frequently than the women from falls, or why they should be so much more liable to injury from projecting nails and flying and falling objects. Possibly men are inclined to stick less closely to their own particular machine and to move about more freely than the women, in which case they would naturally be more exposed to such dangers. The women show a slight but curious excess in the proportion of accidents due to disregard of orders, but the greatest part of their excess is found among the accidents due to the ordinary use of the machine.

The underlying causes of the accidents, so far as they could be determined from the records, are given in the following table:

UNDERLYING CAUSE OF ACCIDENTS TO PRESS HANDS, BY SEX.

Underlying cause of accident.	Male.		Female.		Total.	
	Number injured.	Per cent.	Number injured.	Per cent.	Number injured.	Per cent.
Worker not taking ordinary care	28	3.26	20	1.81	48	2.44
Worker taking risks	62	7.22	103	9.31	165	8.40
Removal of safeguards	21	2.44	13	1.18	34	1.73
Inattention to surroundings	12	1.40	9	.81	21	1.07
Unforeseen liability	74	8.61	71	6.42	145	7.38
Imperfect machinery	24	2.79	30	2.71	54	2.75
Fellow worker	7	.82	2	.18	9	.46
Not disclosed by record	631	73.46	858	77.58	1,489	75.77
Total	859	100.00	1,106	100.00	1,965	100.00

In this table the first four causes all involve what would ordinarily be considered carelessness or even recklessness on the part of the workers, and just here appears one marked exception to the general attitude of the women. They are, on the whole, it seems, more careful than the men, less given to removing the safeguards which should protect them, more attentive to their surroundings; in fact, they display a marked tendency to avoid danger as far as may be when working on a notoriously dangerous machine. But in the one matter of taking risks they suddenly depart from their conservative attitude and run into danger more recklessly than the men.

A study of the time at which the accidents grouped under this heading occurred, however, throws some light on the subject. "Taking risks" includes a variety of injudicious actions, such as cleaning a machine while in motion, disregarding instructions, attempting to adjust screws, belts, etc., without stopping the press, experimenting with another person's machine, and so on. But the most important cause, numerically, for both men and women, was some manipulation of the material, either in inserting the work, removing it, or clearing away the scrap, which brought their fingers in dangerous proximity to the descending die. Nearly all the excess among women of accidents ascribed to taking risks is due to this cause, the number being 32 for men against 66 for women. A part of the women's greater liability here is probably due to a difference in conditions. It is not unusual to have men operate the heavier and slower machines, while the women are put at the lighter and more rapid. Obviously, the swifter the operation of a press the greater the danger of bringing the fingers near the die, so that the men may be able to do with some degree of safety what is exceedingly dangerous for the women. But a more important consideration is the comparative unfamiliarity of the women with their machines. One-fourth (25.8 per cent) of their accidents from this cause occurred during their first day at the machine, an appreciable number happening within the first hour's operation, while over two-fifths (42.4 per cent) occurred during the first three days after beginning this kind of work. For men the proportion for the first day is 18.7 per cent, and for the first three days 31.2 per cent. These accidents would inevitably be classed as the result of taking risks, but in view of the fact that so large a proportion occurred among beginners it is more probable that they are the result of unfamiliarity with the machine, and of the attitude of strained attention already discussed, than that they are really due to an uncharacteristic and inconsistent recklessness on the part of the women.

A striking feature of this table is the very large proportion of cases in which it was impossible to decide upon the real underlying cause of the accident. Mention has already been made of the widespread impression that the negligence of the worker is a very important, perhaps even the leading, factor in the causation of accidents. A superficial investigation of the subject tends to confirm this impression, but when the evidence concerning causes is tested by the requirements of scientific accuracy, it becomes apparent that carelessness is assigned as a cause in a large number of cases in which it can not fairly be held accountable. It is assumed when, upon careful questioning, even those who make the assumption admit that it does not apply. In literally hundreds of the cases included in the above table, "Carelessness" was the unhesitating explanation of the accident, although even the most elementary study of the circumstances showed that it was but one of many factors, any one of which might with equal propriety have been assigned as the chief cause. The table represents a careful individual scrutiny of each record and the discussion of many cases with the foreman and the injured workman. The result is this large group in which to the inquiry "Where does responsibility rest?" the only possible answer is "Not disclosed."

It will be noticed that this group is larger among the press hands than in the records of cotton-mill accidents shown in the bureau's report on the employment of women and children in the cotton textile industry.[a] This is in accord with the nature of the work. The circumstances which make it dangerous in themselves make difficult the location of responsibility. The machine is an essentially simple one which does not often break down, and so the accidents from defective machinery are not numerous. If the accidents of which the causes are not disclosed by the records are disregarded it will appear that a high proportion of the remainder are assignable to definite fault of the worker. This, too, is in accord with the nature of the work. The neglect of safeguards, the disregard of instructions, the failure to use ordinary care, and the assumption of unnecessary risks are all rather easy of detection, if they actually occur. That they are assigned as causes in relatively so few cases is a very strong indication that as factors in the high accident rate of press hands they are comparatively unimportant.

ACCIDENTS WITH REFERENCE TO TIME SINCE BEGINNING WORK.

Some further light upon the causes both of accidents in general and of the high rate among the women is given by an examination of the length of time the injured workers had been employed upon the kind of machine at which the accident occurred. This fact was recorded in the cases of 1,102 injured press hands and of 1,603 workers injured in other occupations. The following table gives the facts by sex:

NUMBER OF PRESS HANDS AND OF EMPLOYEES IN OTHER OCCUPATIONS INJURED, ACCORDING TO TIME SINCE BEGINNING WORK ON THE MACHINE, BY SEX.

Time of accident in reference to time on the machine.	Press hands.			Other occupations.			All occupations.		
	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.
During 1st day	77	252	329	89	42	131	166	294	460
2d day to end of 1 week	65	163	228	124	61	185	189	224	413
2d week to end of 1 month	61	81	142	158	47	205	219	128	347
2d month to end of 6 months	101	92	193	332	89	421	433	181	614
7th month to end of 1 year	33	40	73	182	50	232	215	90	305
After 1 year	72	65	137	381	48	429	453	113	566
Total	409	693	1,102	1,266	337	1,603	1,675	1,030	2,705

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[a] Cotton Textile Industry, Volume I of this report, p. 389.

The facts recorded in the foregoing table may be presented from another point of view, as follows:

AVERAGE NUMBER OF PRESS HANDS AND OF EMPLOYEES IN OTHER OCCUPATIONS INJURED PER DAY AFTER BEGINNING WORK ON MACHINE, BY SEX.

Occupations.	Average number injured per day.				
	1st day.	2d day to end 1 week.	2d week to end 1 month.	2d month to end 6 months.	7th month to end 1 year.
Press hands:					
Males	77	13	3	0.78	0.21
Females	252	33	4	.71	.26
Total	329	46	7	1.49	.47
Other occupations:					
Males	89	25	8	3	1
Females	42	12	2	.69	.32
Total	131	37	10	3.69	1.32
All occupations:					
Males	166	38	11	3	1
Females	294	45	6	1	.57
Total	460	83	17	4	1.57

Before commenting upon these figures it may be well to consider two possible explanations of the large number of beginners injured among the press hands. It might be that the press hands were a fluctuating group, changing frequently from one occupation to another or from one establishment to another, and so furnishing a number of beginners out of all proportion to the real size of the group. Or it might be that each person who was injured during his first day's work at the machine, discouraged by such a beginning, refused to resume that work after his recovery, thereby rendering it necessary to put on another new hand, and thus again unduly swelling the number of beginners. In reply to these objections, it can only be said that a study of conditions in the establishments under consideration did not seem to sustain either point. The press hands were nearly all drawn from those who had worked in these plants in other occupations for periods ranging up to several years, and there is no indication that upon being put to presswork they at once adopted migratory habits. The second suggested explanation may perhaps have had some weight, but as the records indicate that more than 80 per cent of the injured returned to the same work, it is evident that this cause can at best account for only a small proportion of the number of accidents occurring during the worker's first days at the machine. The number and severity of these accidents, as compared with those of later periods, are shown by the following tables.

NATURE OF INJURY TO PRESS HANDS ACCORDING TO TIME SINCE BEGINNING WORK ON THE MACHINE, BY SEX.

Nature of injury.	Number.			Per cent.		
	1st day.	2d day to end 1 week.	After 1 week.	1st day.	2d day to end 1 week.	After 1 week.
MALES.						
Finger or fingers wholly or partly lost	25	18	68	32.47	27.69	25.47
Finger or fingers crushed or broken	20	13	35	25.97	20.00	13.11
Finger or fingers bruised or lacerated	20	21	100	25.97	32.31	37.45
Cuts on hands or fingers	7	9	40	9.09	13.84	14.98
Cuts, not on hands	1	2	10	1.30	3.08	3.75
Bruises or lacerations, not on hands	3	1	6	3.90	1.54	2.25
Punctured wounds	1	1	3	1.30	1.54	1.12
Infection	....	....	....	....	....	....
Dislocations	....	....	2	....	....	.75
Unclassified	....	....	3	....	....	1.12
Total	77	65	267	100.00	100.00	100.00
FEMALES.						
Finger or fingers wholly or partly lost	51	38	47	20.24	23.31	16.90
Finger or fingers crushed or broken	37	28	42	14.68	17.18	15.11
Finger or fingers bruised or lacerated	135	76	103	53.57	46.63	37.05
Cuts on hands or fingers	24	16	53	9.52	9.82	19.06
Cuts, not on hands	....	1	7	....	.61	2.52
Bruises or lacerations, not on hands	5	1	8	1.99	.61	2.88
Punctured wounds	....	2	5	....	1.23	1.80
Infection	....	....	8	....	....	2.88
Dislocations	....	....	1	....	....	.36
Unclassified	....	1	4	....	.61	1.44
Total	252	163	278	100.00	100.00	100.00

It will be seen that not only did a considerable proportion of all the accidents to press hands happen during the first week at work (considerably over one-half of these occurring during the first day), but that a larger proportion of these accidents were serious than was the case with those befalling more experienced workers. The severe accidents of this occupation are those involving the loss, fracture, or crushing of the fingers, which are found in the first and second groups of the last table. For men and women alike the accidents occurring during the first week show a larger proportion of these severe injuries than those occurring throughout the rest of their experience.

Bearing this fact in mind, it is apparent that the first few days at this work are a time of extreme danger, the first day showing the greatest accident liability. Evidently the idea that the experienced worker has by his familiarity with the dangers of his employment become careless and specially liable to accident does not hold in regard to this occupation. In fact, the whole question of the worker's negligence as a cause of accidents is illuminated by these figures. At the very point where we know the worker is giving the closest possible attention, the first day on the machine, the number of accidents occurring is enormously greater than for any subsequent period. Evidently some other explanation than carelessness must be sought.

The rapid decline of the rate from the proportions of the first day is not a phenomenon of this peculiarly dangerous occupation. The table on page 90 shows the same tendency in the associated occupations, some of which have very slight hazard. In other industries also the relatively higher accident rate for beginners has been observed.[a]

This decline does not mean that the occupation becomes relatively free from hazard as time goes on. The rates for press hands in the last six months of the first year are known to be still much above those of nonpress workers, although exact rates can not be calculated from the data at hand.

The question of the worker's age as bearing upon this situation is worth consideration. All of these workers were over 16, but if those injured in the first day accidents were noticeably younger than those concerned in the later casualties, or if the women who suffered differed materially in age from the men, this fact might afford some explanation of the variations shown in the preceding table. The

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[a] A report of the German imperial insurance office (*Amtliche Nachrichten des Reichs-Versicherungsamts, 1910. I Beiheft I Teil. Gewerbe-Unfallstatistik für das Jahr 1907, p. 328*) shows the number of persons injured in the various industries of Germany in 1907, classified by the length of time they had been employed when the accident occurred. From this report the following table is derived, showing for each class the total number injured in the metal-working industries and in all industries, together with the computed average and relative number injured per day in each accident period. The base used in computing these relative numbers, it will be noticed, is the average number injured per day of persons employed six months and under 1 year. The injuries included are serious injuries involving disability of three months or more.

AVERAGE NUMBER OF PERSONS INJURED PER DAY IN 1907 IN THE METAL-WORKING INDUSTRIES, AND IN ALL INDUSTRIES, OF GERMANY, CLASSIFIED BY DURATION OF EMPLOYMENT IN THE OCCUPATION IN WHICH ENGAGED AT THE TIME OF THE ACCIDENT.

Length of time employed in the occupation.	Number of days in each accident period.	Persons injured in each accident period in—					
		Metal working industries.			All industries.		
		Total number.	Average number per day.	Relative number per day.	Total number.	Average number per day.	Relative number per day.
Less than 3 days (not including casual employees)	3	87	29.0	3,222.2	2,284	761.3	2,080.1
3 days and under 1 week (6 days)	3	38	12.7	1,411.1	1,050	350.0	956.3
1 week (6 days) and under 1 month (26 days)	20	132	6.6	733.3	4,288	214.4	585.8
1 month (26 days) and under 3 months (78 days)	52	156	3.0	333.3	5,960	114.6	313.1
3 months (78 days) and under 6 months (156 days)	78	124	1.6	177.8	5,092	65.3	178.4
6 months (156 days) and under 1 year (312 days)	156	146	.9	100.0	5,705	36.6	100.0

following table gives the average age of the injured workers according to the time they had been employed upon the machines at which the accident occurred:

AVERAGE AGE OF MALE AND FEMALE MACHINE OPERATORS INJURED WITHIN SPECIFIED TIME OF BEGINNING WORK ON THE MACHINE.

Sex.	Average age of employees injured within specified time after beginning work on the machine.						
	1st day.	2d day to end of 1 week.	2d week to end of 1 month.	2d month to end of 6 months.	7th month to end of 1 year.	After 1 year.	Total.
Male	22.65	21.64	22.03	22.09	23.88	32.12	25.06
Female	20.56	20.81	19.58	19.05	19.68	21.69	20.27

The table indicates that age is not an important factor in the situation. For males the average age of those injured during the first day is actually greater than of those injured in the three succeeding periods. For females the average age of those hurt during the first day is more than a year higher than of those hurt between the end of the first and the end of the sixth month. The average age of the males is higher than that of the females, but both sexes had passed the age below which physical immaturity and youthful incapacity to realize danger might account for a high accident rate. As concerns the first day, especially if age had any marked influence, the situation should be the exact reverse of what it is, since for neither sex is the lowest average age found here, and the difference between the sexes is not so great as in some of the later periods in which the number and proportion of accidents are more nearly equal.

The difference between men and women in regard to the accident liability of the first day is striking. The table on page 89 shows that of the 409 accidents to male press hands, for which the time at work on the machine prior to the accident is known, 77, or 18.83 per cent, and of the 693 to females 252, or 36.36 per cent, occurred on the first day at work. Taking the first week instead of the first day, the disparity, though somewhat less, is still striking, the percentages being for men 34.72 and for women 59.88. These figures indicate that a considerable portion of the excess of the women's accident rate among press hands is to be attributed to the first few days on the machines. There are even some indications that could the beginners be excluded and full data secured concerning accidents among the experienced press hands, the accident rate for women in this highly dangerous occupation would be actually less than for men. The character of the data as yet obtainable, however, does not justify definite conclusion upon this point.

Something may now be suggested concerning the causes of the special hazard of women. Why should their accident rate, so greatly in some cases and so constantly, exceed that of males?

The following suggestions are offered. They must be regarded as nothing more than provisional:

(1) Nervous organization: The inherent sensitiveness of woman's nervous system is both a help and hindrance industrially. It makes her quicker and readier than the male worker. It also subjects her to greater danger, especially during the initiatory period.

(2) Strength: Muscular energy counts in the struggle with the machine. In a given instance the less powerful woman may be drawn within the range of injury when the greater strength of the man would save him.

(3) Training: The boy is brought up with tools, while the girl, as a rule, has little familiarity with them. The fact that the great excess of accidents among women is found almost wholly within the first week after beginning work on the press, and that at later periods the recorded accidents are usually fewer proportionately among them than among the men, seems to indicate that this cause is more effective than any other.

DISTRIBUTION OF ACCIDENTS THROUGH THE HOURS OF THE DAY.

The general tendency to ascribe industrial accidents to carelessness leads to the use of the word even when it is clearly evident that it is inapplicable. Thus in the writings of an eminent authority on industrial hygiene we find this sentence: "It is largely owing to the influence of fatigue that, as the day proceeds, the workers, becoming tired in mind and body, become careless, and as a consequence the number of accidents increases with the hours of toil."

Here it is obvious that the writer himself looks upon fatigue as the underlying and therefore the real cause of the accidents which nevertheless he ascribes to carelessness. The unfortunate feature of this use of the word lies in the fact that it carries with it an implication of fault. To call a workman careless charges him with some degree of complicity in whatever may befall him. But the fatigued man or woman can not justly be accused of such complicity. He has lost in greater or less measure those instinctive protective activities which are a safeguard under normal conditions, and his consequent inability to exercise them is a misfortune, not a fault.

But disregarding, for the present, the question of responsibility, it is worth while to see what light the data obtained may throw upon the probable influence of fatigue as a cause of accidents. For this purpose a table has been prepared showing the distribution of accidents through the working hours of the day.

This table combines the results obtained from the records of 19 establishments engaged in metal manufacture, 126 cotton mills for a period of one year, and one cotton mill for a period of eight years,[a] the unpublished records of the Indiana Department of Factory Inspection for three years, and the published tabulation of the Wisconsin Bureau of Labor.[b]

The establishments from which records were obtained employed 11,178 males and 3,781 females, a total of 14,959. Since the records were obtained for an average period of 3.47 years, this represents workers to the number of 51,908 laboring for one year. The number working in the cotton mills for one year was 64,571, and the single mill for eight years represents 10,816 working for one year. In all 127,295 worker years are represented by the portion of the table based upon records gathered at first hand.

It is probable that the figures drawn from the two States represent an even larger number of worker years. According to the Federal census, there were in 1905 an average of 154,174 wage-earners in factories in Indiana and 151,391 in Wisconsin.[c] These numbers had undoubtedly changed somewhat by the time the State reports were compiled, but there is no reason to suppose that they had decreased.

These figures are given because the number of persons exposed to given hazards is of the utmost importance to the validity of any conclusions.

As this section of the study is particularly devoted to press hands, their figures are given in detail. On account of their relatively small number their showing can not be given the same weight as that of the larger groups.

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[a] Cotton Textile Industry, Vol. I of this report, p. 395.

[b] Fourteenth Biennial Report of the Wisconsin Bureau of Labor and Industrial Statistics, 1909–10, Part II, p. 78.

[c] Census of Manufactures, 1905, Part II, pp. 255, 1179.

DISTRIBUTION OF INDUSTRIAL ACCIDENTS THROUGH THE HOURS OF THE DAY.[a]

Hours.	Metal-working establishments.									
	Accidents to press hands.				Accidents to other workers.				Total accidents.	
	Male.	Female.	Total.	Per cent.	Male.	Female.	Total.	Per cent.	Number.	Per cent.
6 to 7 a. m	....	....	....	....	....	....	....	....	....	....
7.01 to 8 a. m........	48	79	127	6.91	322	37	359	8.18	486	7.81
8.01 to 9 a. m........	95	100	195	10.61	429	53	482	10.98	677	10.87
9.01 to 10 a. m	**105**	**128**	**233**	**12.68**	**562**	65	**627**	**14.29**	**860**	**13.81**
10.01 to 11 a. m......	96	115	211	11.48	480	**72**	552	12.58	763	12.25
11.01 a. m. to 12 m...	66	79	145	7.89	303	43	346	7.89	491	7.89
12.01 to 1 p. m	38	52	90	4.89	132	19	151	3.44	241	3.87
1.01 to 2 p. m	83	92	175	9.52	372	55	427	9.73	602	9.67
2.01 to 3 p. m	**102**	103	205	11.15	416	55	471	10.73	676	10.86
3.01 to 4 p. m	98	**124**	**222**	**12.08**	**435**	**59**	**494**	**11.26**	**716**	**11.50**
4.01 to 5 p. m	76	89	165	8.98	300	46	346	7.89	511	8.21
5.01 to 6 p. m	34	36	70	3.81	118	15	133	3.03	203	3.26
6.01 to 7 p. m	....	....	....	....	....	....	....	....	....	....
7.01 to 8 p. m	....	....	....	....	....	....	....	....	....	....
Total..........	841	997	1,838	100.00	3,869	519	4,388	100.00	6,226	100.00

Hours.	Cotton mills.[b]				General manufacture.				Grand total.	
	126 mills 1 year.		1 mill 8 years.		Indiana 3 years.		Wisconsin.			
	Number of accidents.	Per cent.	Number of accidents.	Per cent.	Number of accidents.	Per cent.	Number of accidents.	Per cent.	Number of accidents.	Per cent.
6 to 7 a. m	73	6.19	63	8.22	....	....	....	....	136	0.91
7.01 to 8 a. m........	95	8.05	68	8.88	546	11.31	76	4.02	1,271	8.53
8.01 to 9 a. m........	126	10.68	82	10.71	492	10.19	126	6.67	1,503	10.09
9.01 to 10 a. m	**161**	**13.64**	90	11.75	**603**	**12.49**	227	12.01	**1,941**	**13.04**
10.01 to 11 a. m......	128	10.85	**114**	**14.88**	469	9.71	**245**	**12.96**	1,719	11.54
11.01 a. m. to 12 m...	78	6.61	43	5.61	338	7.00	208	11.00	1,158	7.78
12.01 to 1 p. m	58	4.92	9	1.18	183	3.79	49	2.59	540	3.63
1.01 to 2 p. m	78	6.61	63	8.22	441	9.13	126	6.67	1,310	8.80
2.01 to 3 p. m	98	8.30	67	8.75	481	9.97	213	11.27	1,535	10.31
3.01 to 4 p. m	**126**	**10.68**	**77**	**10.05**	**598**	**12.38**	**240**	**12.70**	**1,757**	**11.80**
4.01 to 5 p. m	90	7.63	57	7.44	480	9.95	229	12.12	1,367	9.18
5.01 to 6 p. m	59	5.00	33	4.31	197	4.08	151	7.99	643	4.32
6.01 to 7 p. m	7	.59	....	....	....	....	....	....	7	.05
7.01 to 8 p. m	3	.25	....	....	....	....	....	....	3	.02
Total..........	1,180	100.00	766	100.00	4,828	100.00	1,890	100.00	14,890	100.00

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[a] In the Twelfth Annual Report of the Minnesota Bureau of Labor, p. 137 et seq., appears a tabulation and charting of over 10,000 accidents, by hours. These are not so arranged as to be exactly comparable with this table, but show a similar distribution.

[b] See Cotton Textile Industry, Vol. I of this report, p. 395.

In this table the period from 7 a. m. to 12 noon is one of almost perfectly uniform employment. The entire force is, except for cases of injury or illness or other causes of absenteeism, at work. These absences will, of course, in so large a group be distributed over the hours regularly and so not disturb the number of persons exposed.

The period from 1 to 5 in the afternoon is of nearly the same character. The last hour is clearly influenced by a lessening number of people employed. Very many establishments close at some point between 5 and 6, either constantly or at some period of the year.

This undoubtedly accounts in large measure for the lessened number of accidents during that hour, as compared with the last hour of the morning.

The most notable feature of this table is its remarkable accord from group to group. Here are four sets of figures, collected by different agencies in different parts of the Union at different times and covering different industries, each agency working independently of the others. Yet the figures thus gathered show the striking similarity displayed above.

The distribution of accidents shown here is decidedly unexpected in two particulars. The hourly proportion of accidents does not increase as the day goes on, reaching its maximum during the last hour of work. On the contrary, for both morning and afternoon there is an accident peak or summit, occurring in each case at about the middle of the working period, after which the proportion declines until the close of the half day. A second unexpected feature is that the proportion of accidents is very generally greater for the morning than for the afternoon. Disregarding the hours before 7 in the morning, after 6 o'clock in the evening, and between 12 and 1 o'clock, all periods during which the number of workers was presumably much diminished, and comparing the two uninterrupted periods of the morning and the afternoon, the percentages of accidents for each stand as follows:

DISTRIBUTION OF INDUSTRIAL ACCIDENTS BETWEEN MORNING AND AFTERNOON.

Workers to whom accidents occurred.	Per cent of total accidents occurring from 7 a. m. to 12 m.	Per cent of total accidents occurring from 1 p. m. to 6 p. m.
Press hands (metal-working factories)	49. 57	45. 54
Other workers (metal-working factories)	53. 92	42. 64
Operatives 126 cotton mills, 1 year	49. 83	38. 22
Operatives 1 cotton mill, 8 years	51. 83	38. 77
Indiana, 3 years	50. 70	45. 51
Wisconsin, 1 year	46. 66	50. 75
Total	50. 99	44. 41

A considerable part of this difference is no doubt attributable to the Saturday afternoon half holiday which many of these workers have in the summer and some throughout the year. That it is not wholly explicable upon this ground is shown by the figures for the cotton-mill operatives, among whom the Saturday short day is almost universal, their week consisting of six forenoons and five afternoons. If, then, accidents occurred at the same rate throughout the day, the morning hours should show six-elevenths and the afternoon hours five-elevenths of the total. In other words, the excess of morning accidents should be 20 per cent. Instead of this, among the workers in the 126 cotton mills the excess of morning accidents is 30.38 per cent and among the workers in the one mill 33.69 per cent; that is, in both cases the morning excess is more than half as large again as can be accounted for on the ground of the half holiday.

Whatever weight may be ascribed to the half holiday as altering the proportions between morning and afternoon, it is evident that it can have no effect upon the distribution within each period. The hours at which accidents occur during five afternoons will not be affected by the fact that on the sixth afternoon the worker has a holiday. But the decreasing rate for the hours between 10 and 12 in the morning and 4 and 6 in the afternoon renders it impossible to explain the accident rate by the plausible theory that as the day goes on the worker becomes tired, that fatigue leads to so-called carelessness, and carelessness to accident. Apparently the accident rate is a complex product, dependent on a variety of factors concerning which we have as yet little information.[a]

SPEED OF PRODUCTION FROM HOUR TO HOUR IN ONE ESTABLISHMENT.

One factor which probably has a very marked influence is the rate of production. It is a truism that the faster a machine operates, other things being equal, the greater the danger of accident from it. In one factory visited the stamping presses were equipped with automatic counters for registering the production. The speed of

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[a] The following statement shows for the year 1907 the number and per cent of injured persons in the metal-working industries and in all industries of Germany who had been at work each specified number of hours on the day of the accident, and is taken from a report of the imperial insurance office (*Amtliche Nachrichten des Reichs-Versicherungsamts, 1910. I Beiheft I Teil. Gewerbe-Unfallstatistik für das Jahr 1907, p. 329.*) The figures are interesting in this connection, but are not strictly comparable with those in this report, which specify the hour of the day when the accident happened. The injuries included are serious injuries, involving disability of three months or over.

NUMBER AND PER CENT OF INJURED PERSONS WHO HAD BEEN AT WORK EACH SPECIFIED NUMBER OF HOURS ON THE DAY OF THE ACCIDENT, FOR METAL-WORKING INDUSTRIES AND FOR ALL INDUSTRIES IN GERMANY, 1907.

Number of hours injured person had been at work.	Metal-working industries.		All industries.	
	Number reported.	Per cent.	Number reported.	Per cent.
Less than 1	88	5.79	3,939	4.94
1 and under 2	125	8.23	6,885	8.63
2 and under 3	133	8.76	7,351	9.21
3 and under 4	**209**	**13.76**	9,004	11.28
4 and under 5	199	13.10	**9,739**	**12.20**
5 and under 6	135	8.89	8,106	10.16
6 and under 7	116	7.64	6,462	8.10
7 and under 8	**161**	**10.60**	**6,908**	**8.66**
8 and under 9	141	9.28	6,817	8.54
9 and under 10	109	7.18	6,041	7.57
10 and over	103	6.77	8,539	10.71
Total	1,519	100.00	79,791	100.00

these machines depended entirely upon the operator, since for each piece formed he must actuate a treadle. This suggested that by taking these records from hour to hour some light might be thrown upon the problem under discussion. Evidently the worker's activity will be reflected with some accuracy in the output of his machine.

From the records thus obtained all of those were chosen which represented uninterrupted operation of the machines for entire days. Twenty-three machines had such records for periods varying from one day to seven days. The accompanying table gives the details:

HOURLY PRODUCTION ON STAMPING PRESSES.

Days recorded.	7 to 8.	8.01 to 9.	9.01 to 10.	10.01 to 11.	11.01 to 11.30.	12 to 1.	1.01 to 2.	2.01 to 3.	3.01 to 4.	4.01 to 4.30.
7	6,963	6,870	6,958	7,115	3,667	6,625	7,145	7,040	7,186	4,481
1	626	724	740	724	421	733	732	751	749	350
1	1,128	1,158	1,143	1,211	732	1,128	971	1,243	1,129	643
1	850	823	810	860	337	1,012	1,023	1,021	1,011	533
1	1,140	1,250	1,425	1,207	867	1,215	1,150	1,502	1,056	748
1	942	1,279	1,135	1,277	851	1,206	1,151	1,432	1,440	533
3	1,289	1,366	1,452	1,297	606	1,410	1,499	1,402	1,303	635
1	1,759	2,142	1,800	1,900	994	1,919	1,890	1,979	1,506	965
3	3,815	3,806	3,843	3,882	1,975	3,402	3,655	3,677	3,861	1,987
2	1,297	1,237	1,906	1,584	725	1,801	1,786	1,490	1,408	810
1	1,400	1,400	1,400	1,400	725	1,375	1,400	1,400	1,424	676
2	1,592	1,587	1,608	1,621	802	1,589	1,564	1,597	1,569	769
1	911	1,001	1,043	987	579	1,031	1,013	1,086	998	508
5	1,652	1,893	1,906	2,029	968	1,964	2,158	2,005	2,074	971
1	320	398	420	400	111	453	415	433	521	202
1	1,455	1,455	1,455	1,455	730	1,445	1,445	1,455	1,545	730
1	474	422	438	479	197	493	422	467	459	219
5	2,278	2,198	2,271	2,211	1,226	2,158	2,203	2,234	2,252	1,149
1	949	1,097	832	972	406	544	1,072	994	944	540
2	1,104	1,309	1,007	1,332	693	1,279	1,286	1,291	1,178	661
5	2,059	2,512	2,560	2,417	1,347	2,345	2,584	2,648	2,630	1,153
3	2,162	2,507	2,586	2,473	1,367	2,409	2,434	2,441	2,346	1,229
4	1,466	1,421	1,463	1,483	791	1,620	1,594	1,670	1,784	513
53	37,631	39,855	40,201	40,316	21,117	39,156	40,592	41,258	40,373	21,005

The totals of this table show an increasing production through the morning hours. In the afternoon, beginning at nearly the same point as in the morning, there is a rise up to 3 o'clock, a drop in the next hour, and a recovery of the rate in the last half hour.

The data may be presented in another form indicating still more definitely an accelerated rate as each work period proceeds. The distribution of high points of production may be shown as follows for the four full hours of each period:

NUMBER OF MACHINES SHOWING HIGHEST PRODUCTION AT SPECIFIED HOURS.

Morning.			Afternoon.		
Hour.	Number of machines.	Number of days recorded.	Hour.	Number of machines.	Number of days recorded.
7 to 8	1	5	12 to 1	2	3
8.01 to 9	3	3	1.01 to 2	4	10
9.01 to 10	8	17	2.01 to 3	9	17
10.01 to 11	9	26	3.01 to 4	8	23
Total	[a] 21	51	Total	23	53

[a] Two machines had a uniform record through the hours of the morning.

The rates maintained in the last half hour are in excess of those at the earlier hours on 14 machines in the morning and less on 9 machines. In the afternoon 10 machines have a higher rate and 13 a lower at this period. It will be observed that this relation of machines in the afternoon is not in accord with that shown by the totals of production in the table. In a small group like this the output of a majority of the individual operators is rather more significant than their gross product. Since a majority of operators show a less product in the last period of the day, although the gross product is somewhat higher, there is clearly suggested an average slackening of activity during the last hour and a half of the day.

This record probably discloses one constant factor of the accident rate. Any increase of speed of operation, unless accompanied by some counteracting safeguard, may be expected to show a higher accident rate. That such increase of speed during part or all of the work period is the general practice is common opinion. The foregoing table shows the extent of the increase and the point of maximum production in a single important factory. From so small a group it is impossible to draw general conclusions. Before any definite conclusion could be reached it would be necessary to study the records of both accidents and production in the same establishments covering a considerable period.

From the table showing the distribution of accidents the peak of accident occurrence appears to be near the middle of the work period. That the actual summit in that period must be somewhat later than the middle of the period is suggested by the fact that in two important groups, the cotton mill for eight years and the Wisconsin tabulation, it appears in the fourth hour of the morning. The summit apparently comes a little earlier in the afternoon than in the morning.

The existence of a Saturday half holiday in summer for a considerable portion of these workers depresses the afternoon totals, but does not change the hourly relations in any probably appreciable degree.

It is evident that in the interrelation of influences acting upon the situation now one and now another may be dominant. The most constant factor will be fatigue. It will be present in varying proportion in every case. It may act with the tendency to increase speed to produce a greater number of accidents. It may in the end become so pronounced that speed is reduced and the accident rate lowered.

It is safe probably to offer as a provisional hypothesis that the immediate cause of a variation in the accident rate through the hours of the day is the varying rate of activity. Fatigue then comes in as an important secondary factor, serving sometimes to increase the accident rate, sometimes to decrease it.

There will be some tendency to minimize the factor of fatigue in the above process, because it is not a matter of acute sensation. We can recognize, and measure with some accuracy, the gradual increase of the fatigued condition before sensation begins to advise of its presence. It is a steadily progressive process. It gradually upsets those nice adjustments of the living organism upon which depend efficient labor and the safety of the worker. The margin of safety in modern industry is small. It is measured too frequently by fractions of an inch. Reduce the alertness and the exactness with which the body responds to the necessities of its labor, and by just so much have you increased the liability that the hand will be misplaced that fraction which means mutilation.

CONCLUSIONS IN REGARD TO ACCIDENTS IN THE METAL TRADES.

The conclusions to which a study of accidents in the metal trades as set forth in the foregoing pages leads may be summarized as follows:

(1) The hazard to women in these industries is distinct and considerable.

(2) When men and women work at the same task, its dangers menace the woman much more seriously.

(3) The employments of children have in general only those dangers common to all factory work. Their employment at dangerous tasks is rare and seems to be decreasing.

(4) Negligence of the worker as a cause of accident has been greatly overemphasized.

(5) The accidents of most frequent occurrence are largely preventable.

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